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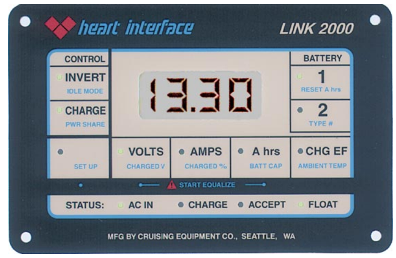

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- **Learns Charging Efficiency**
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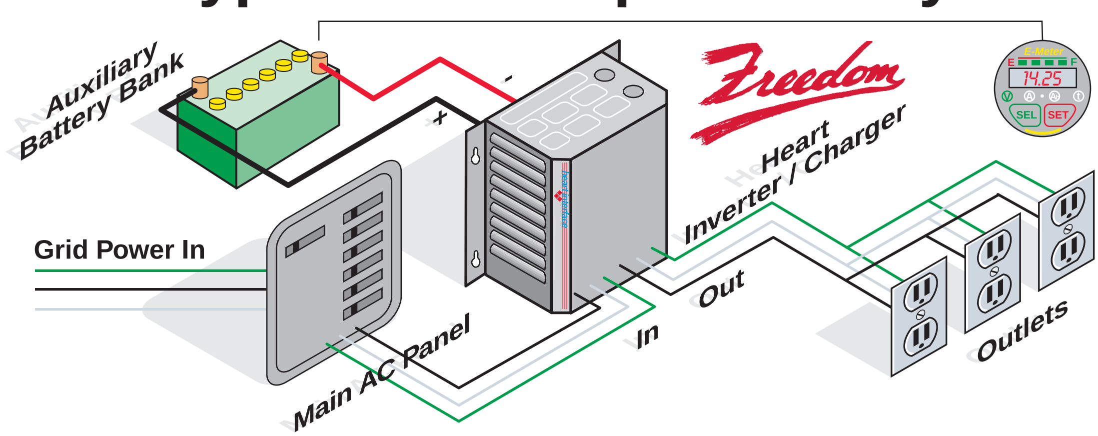
Typical Back Up Power System



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HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

Issue #55 October / November 1996

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GoPower

Fundamentals

Features

Cover: The turn-of-the-century homestead and trading post on Oregon's Rogue River. Story on page 6.

Homebrew

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Regulars

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Access Data

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Energy Park, Oregon Country Fair 1996. Photo by Bart Orlando

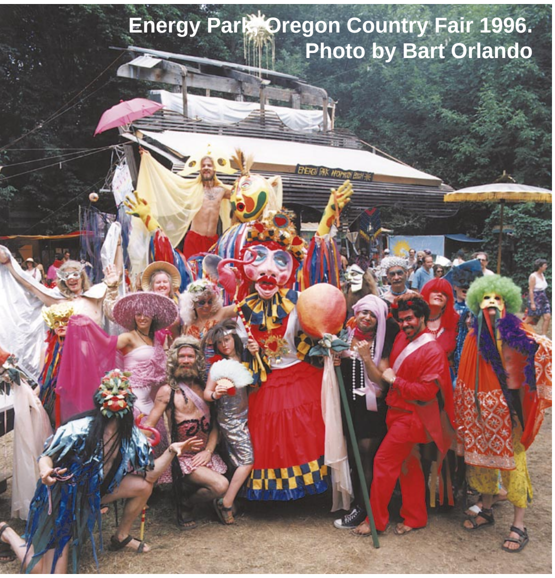
Wired or Empowered?

The word is getting around. We have a choice—we can be wired or we can be empowered.

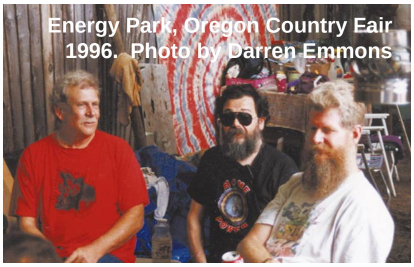
After two massive blackouts on America's West Coast during the last two months, even President Clinton is asking, "What's going on with the electricity?"

Blackouts are things home power people watch on TV. We are independent, self-sufficient, systems—our energy is made on site from sun, wind, and falling water. We know where our power comes from. We know that independence means reliability. We know that simplicity means reliability. The word is getting around….

Richard Perez for the Whole Home Power Crew



Energy Park, Oregon Country Fair 1996. Photo by Bart Orlando



Energy Park, Oregon Country Fair 1996. Photo by Darren Emmons

Reggae on the River 1996

People

Mick Abraham
Matt Armstrong
John Bethea
William von Brethorst
Sam Coleman
Darren Emmons
Lincoln J. Frost, Sr.
Steen Hansen
Chuck Heath
Kathleen Jarschke-Schultze
Stan Krute
Michael Lamb
Don Loweburg
Harry Martin
Bart Orlando
Karen Perez
Richard Perez
Shari Prange
Benjamin Root
Bob-O Schultze
Lori Stone
Michael Welch
John Wiles
Clive Wilkenson
Myna Wilson

" Think about it…"

"At first it was only a dream. Now it's a plan."

Lori Martin

see Letter on page 101

SOLAR DEPOT

four color on film

full page, bled

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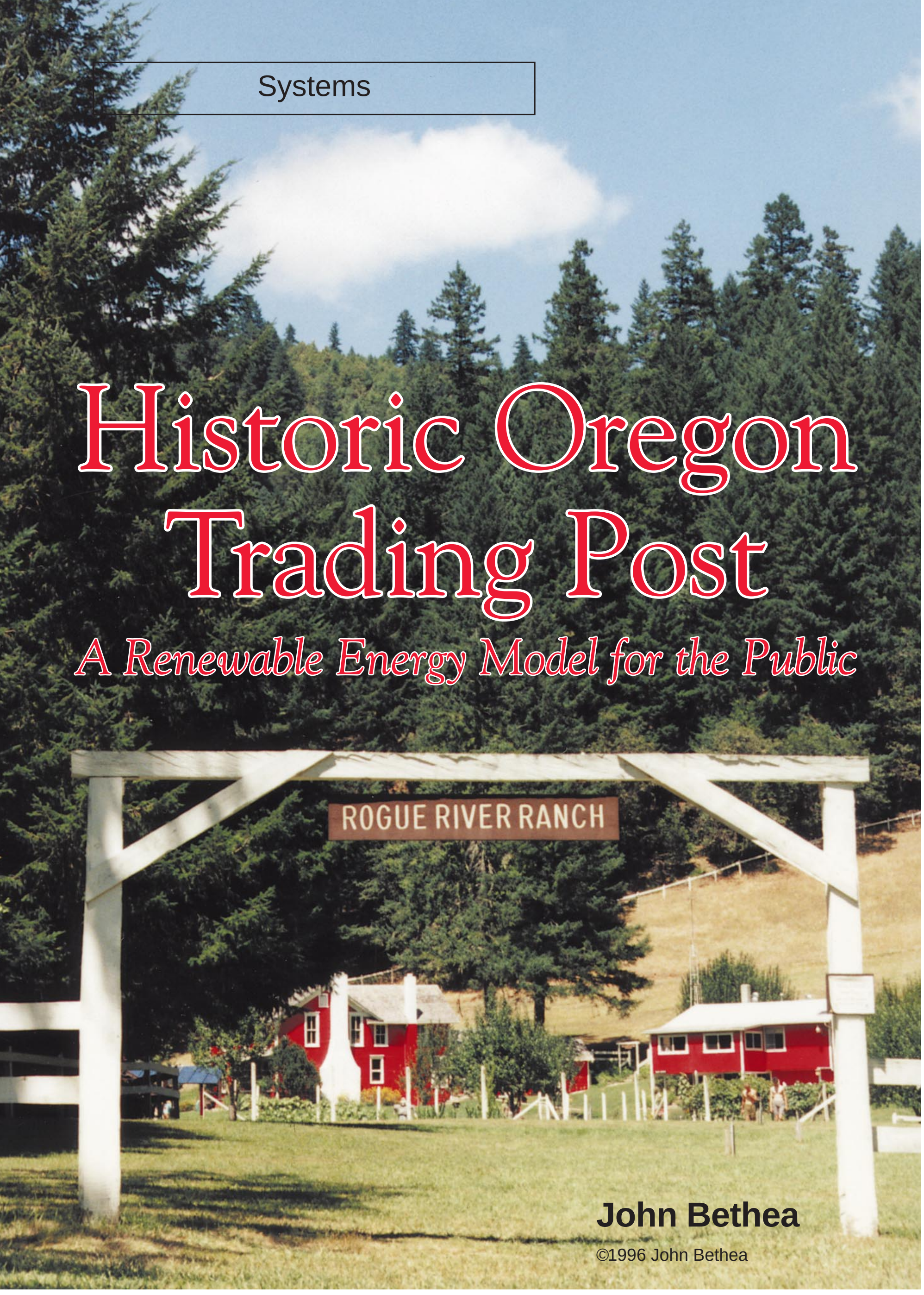


Historic Oregon Trading Post

A Renewable Energy Model for the Public

John Bethea

The Rogue River Ranch, which is on the Register of Historical Places, is located in southern Oregon on the beautiful Wild and Scenic Rogue River. The Bureau of Land Management (BLM) has managed the Ranch since 1970. Having used propane fueled generators at the Ranch from 1970 until the present, the BLM saw an opportunity to get away from all the fuel expenses, noise, pollution, and mechanical breakdowns. With the Ranch averaging about 20,000 visitors a year, what an opportunity to demonstrate renewable energy!

Learning about hydro power

In 1980 while living at and working full time restoring the Rogue River Ranch, I was rummaging through and trying to organize one of the old buildings. A 1940's era cast-iron, 12 inch pelton wheel caught my eye. After doing a lot of research and desperately wanting to free myself of the hassles associated with operating propane generators (the Ranch is about 30 miles as the crow flies from the nearest power lines) I rebuilt and hooked up the pelton wheel. We had a gravity fed water system with about 2500 feet of 2 inch poly pipe creating a static pressure of about 60 psi.

I went to the local alternator shop and got a Delco that they thought would work the best. I put two 12 Volt 8D batteries in parallel and buried 4/0 USE aluminum cable for a run of 200 feet to the caretakers house. I wired the house for a 12 VDC system which included lights, TV, and a small communications system. All of the major appliances were propane.

The pelton wheel had a 17 inch pulley wheel on it and I put a belt to the alternator resulting in the alternator putting out about 5 Amps. In the winter I could run the wheel as much as needed and in the summer about 25% of the time since the water was needed for irrigation. That was plenty for me at the time. I'd only have to run the propane generator once in a rare while!

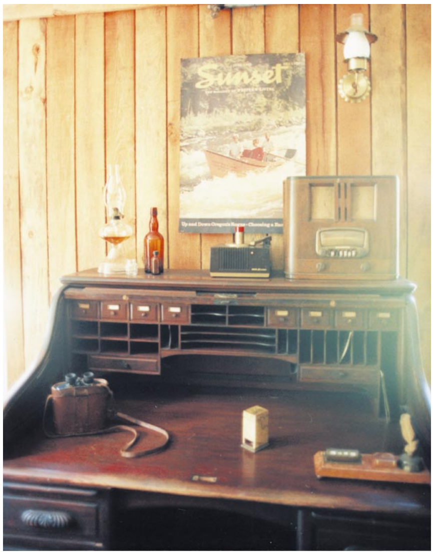
Learning about PV and inverter systems

The Ranch had been restored and set up as an interpretive cultural site for the history of the entire area.It sees about 20,000 visitors a year that can take a self guided tour of the buildings and enjoy the grounds and setting. I no longer live full time at the Ranch but supervise the caretakers who live there from May first to November first each year.

Late in 1991, while visiting the current caretakers Laura and Loren Rush at their winter home in Baja California, I was very impressed with some of the PV-inverter systems their neighbors had. I felt that adding a PV-inverter system to the 12 VDC hydro system at the Ranch would not only fit in well but really cut back on using the propane generator. Generator power demands had again increased over the years.

Above: The main house, built in 1903 by George Billings, became a trading post, boarding house, and eventually a post office.

Wanting to learn more, I spent a lot of time at the library where I found lots of reading material. I found the best help in *Real Goods' Solar Living Source Book* which contains a lot of easy to understand information. In 1991 when a decision was made to put the money we had budgeted for a new generator into upgrading the hydro system and adding a PV - inverter system, the technical help received from the Real Goods staff was very comforting.



Above: The turn of the century homestead now displays artifacts that give today's visitors insight into the lifestyle of early settlers and miners.

Hydro

We upgraded the hydro system by replacing the alternator with a custom made one and reduced the pulley wheel on the pelton wheel from 17 inches to 15 inches which gave a better power ratio. The water system was upgraded by replacing all the piping, and getting more elevation on the intake. The system now has about 200 feet of head

Left: Many of the visitors to the ranch are drawn to the area by the "Wild and Scenic" Rogue River and the surrounding wilderness.

Right: A home made hydro turbine of questionable efficiency.

starting with about 800 feet of 4 inch PVC then 700 feet of 3 inch PVC and finally about 1000 feet of 2 inch PVC. There is a 1500 gallon tank at the head. This resulted in increasing the static pressure to about 85 psi with about 65 gpm free flow. The hydro system now produced about 14 Amps at 12 VDC or about 170 Watts.

Solar

We installed six Siemens M-55 modules on a home-made frame and used an SCI 30 Amp controller. We installed four new Trojan L-16 batteries, a Trace 2512

Below: The Scouts in front of the completed power shed foundation slab. The hydro tailraces are in the foreground.

Left: Boy Scouts from the Oregon Roaring Rogue District volunteered their muscles during the construction phase of the project.

Right: Trenching for the ac and DC wire runs to the main house.

inverter, an APT 400 Amp disconnect, and a TriMetric meter with a 500 Amp shunt. This system worked really nice. The problems were mainly that in a few short years the demands for power had been steadily increasing and this was a fairly small system. The Trace 2512, being a modified sine wave, would occasionally burn out something like cordless drill battery chargers! Also, the old pelton wheel wouldn't work well in the fall when available water volume dropped. In all candor we had a few wiring and fuse installations that were less than what code calls for.

Opportunity to get educated

With the exception of helping put in a few other small PV systems, my experience and knowledge weren't really going anywhere. In the summer of 1995, I jumped at the opportunity to attend the Advanced Photovoltaics and Wind Power courses at Solar Energy International in Carbondale, Colorado. The four weeks I spent there confirmed a lot I had been doing right and wrong.

Partnership

Seeing the need for a much larger renewable energy system at the ranch, a proposal was made for a new system but there wasn't much hope of getting it funded. Then in September 1995, a memorandum with a survey attached came across my desk.

The Bureau of Land Management (BLM) and the U.S. Department of Energy's Sandia National Laboratories' Photovoltaic Systems Assistance Center formed a partnership titled "Renew the Public Lands". The purpose of this partnership is to expand the use of photovoltaics and other renewable energy sources within the BLM.

Above: Solar, wind, and hydro generation is centralized in the new, but traditional looking, power shed.

Left: Jason Miniken wires the Solarex MSX-83s as part of the 24 Volt system.

Below: John Bethea mounts the Air 303 on top of the 27 foot tower.

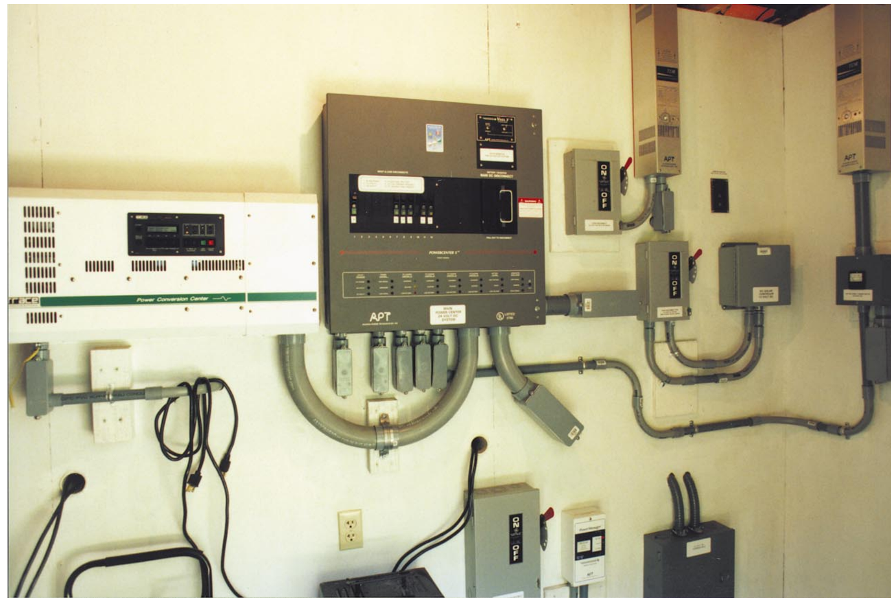
Under the partnership, a comprehensive survey of current BLM photovoltaic use and acceptance was conducted. In addition to the survey, new opportunities for the expanded use of photovoltaics were identified, and several pilot projects were developed. The Rogue River Ranch was selected as one of the pilot projects. The Medford District (BLM) agreed to provide about 65% of the funding needed and Sandia National Laboratories provided the rest. We agreed to use Sandia's money only for construction, etc., so it would not appear they were pushing any particular product. Trent Duncan, an engineer with the BLM Utah State Office, and Hal Post with Sandia National Laboratories oversaw more than 30 projects completed in 1996 on BLM lands nation-wide.

Coming up with the Bureau of Land Management's Medford District share of the cost was a problem. This was solved by doing a major trail maintenance and construction project with volunteer help instead of contracting the project out as was budgeted. This provided enough savings to fund the project. I'd like to thank the Roaring Rogue District of the Boy Scouts of America and veterans from the White City Domiciliary for their help! They not only helped with getting the trial work done but with the Renewable Energy Project as well.

Below: The business end of the Harris Hydroelectric turbine.

Above: While the Southwest Windpower Air 303 is on a relatively short tower at a relatively poor wind site, its value in educating the public justifies its cost.

Below The Harris Hydroelectric pelton turbine produces 26 Amps on the 24 Volt system from 65 psi of dynamic pressure.

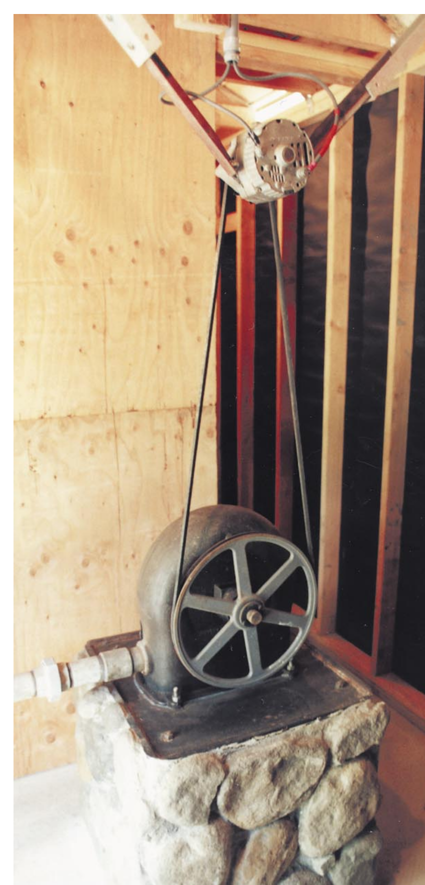


Putting it all together
The first step was to come up with a design for the system, not easy when you haven't done a lot of this before. After completing a basic design I took the liberty of asking a lot of questions from a lot of people. The technicians at Applied Power Corporation in Lacey, Washington, where I bought a lot of the components were very helpful and knowledgeable. Don Harris, whose pelton wheel we used, was very friendly and helpful. I even bugged Richard Perez at *Home Power* a couple of times. The technicians at Ananda Power Technologies fielded most of my calls and I can't say enough about their willingness to help and advise.

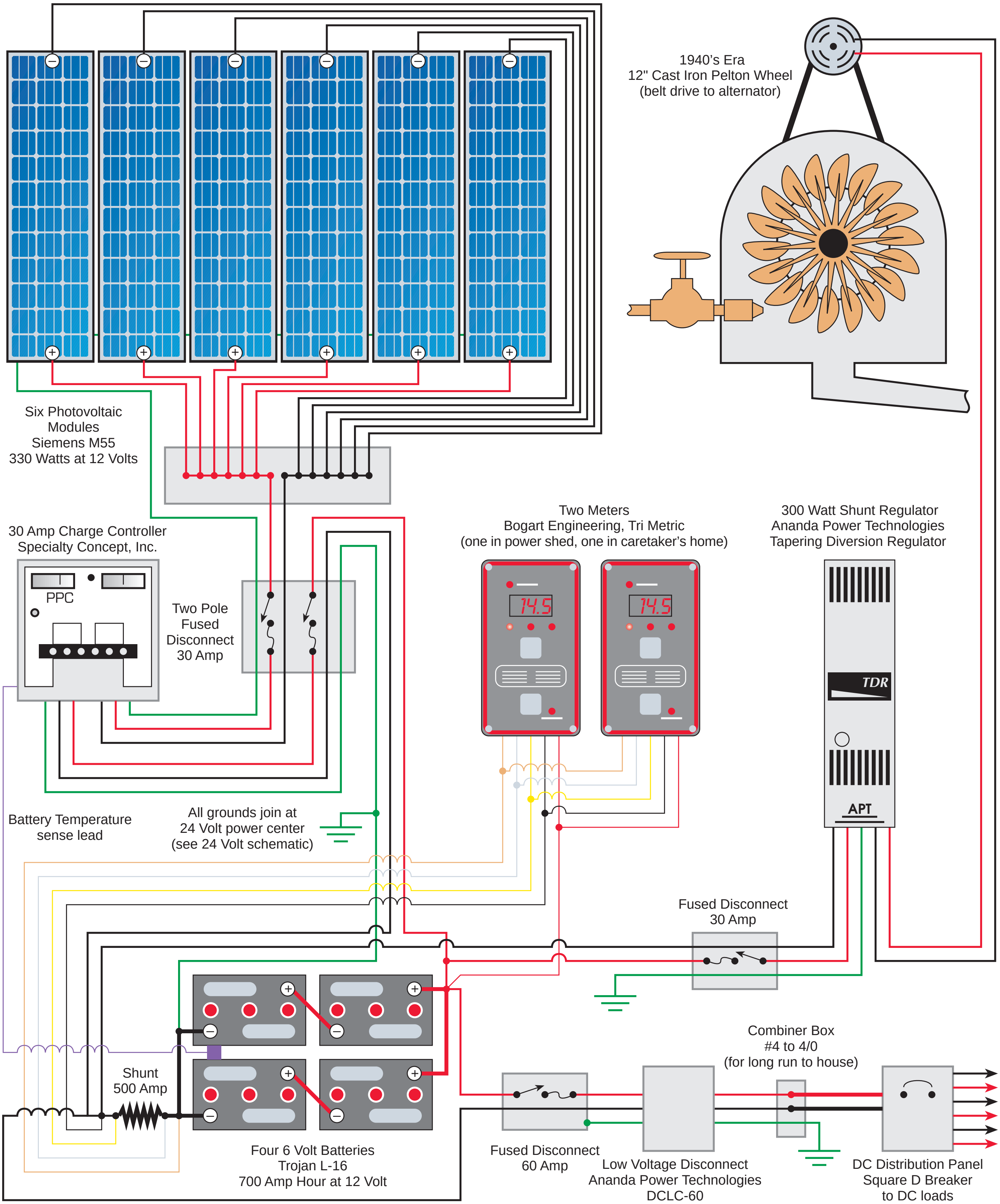
Getting started
It was early this winter when actual construction started. Jason Miniken who works for the Medford District BLM and myself worked on the project as often as time and weather permitted. We built an 18 by 9 foot control building to house the two hydro units, most of the electrical and electronics, and the two separate battery banks. We built two completely different systems side by side in the same building.

Above: The componentry of both systems is on display, with descriptions, for the public.

Below: A 1940's Pelton wheel, found on site, contributes 200 Watts to the 12 Volt system.



The Rogue River Ranch 12 Volt System



Above: The caretakers house, built in 1931, now has 12 VDC, 24 VDC, and 120 vac service and all the modern conveniences.

First system – 12 Volt DC
Most the components that we had in the existing 12 VDC system were taken down and used in a redesigned system. However, the Trace 2512 inverter was taken out of the system. We installed proper fused disconnects, new wiring, two 12 VDC distribution centers, a 300 Watt Ananda TDR (Tapering Diversion Regulator) for the old pelton wheel, a low voltage disconnect, a new pole-top mount for the Siemens M-55 modules, and a remote meter. We cleaned up and reused the four existing Trojan L-16 batteries.

Second system – 24 Volt DC
This system has twelve Trojan L-16 batteries. There are two sub-arrays, each with six Solarex MSX-83

Above: Laura and Loren Rush, caretakers at the ranch for four years, love having convenience in the country.

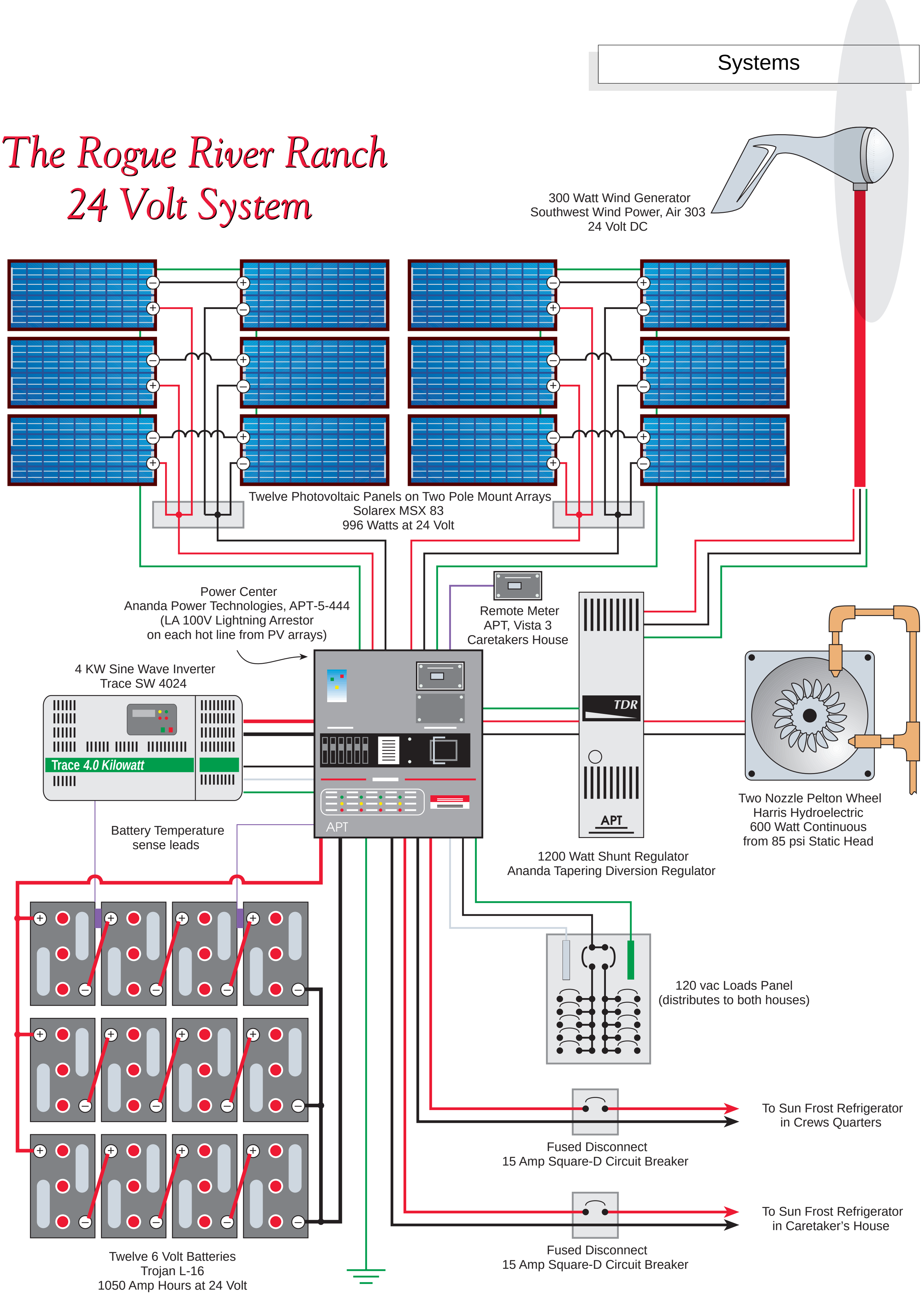
Above: The Rush's kitchen supports them, in style, between monthly trips to the grocery.

modules. A two-nozzle Harris Hydro unit was installed. Only one hydro unit, the Harris or the old cast-iron pelton wheel that's in the 12 VDC system, can be run at a time as they use the same water source. The Harris is producing about 25 Amps at 24 VDC, or about 600 Watts. The wind turbine is an Air 303 that we put on a 27 foot tower beside the control building. Admittedly it's not the best wind site and the tower isn't very high, but we wanted to demonstrate wind power. We were concerned about safety and aesthetics of a higher tower. The Air 303 puts out 1 to 2 Amps a few hours a day. We haven't really had much wind yet, but we expect winter time to produce better results. A 1200 Watt APT-TDR is used to regulate the Harris Hydro and Air 303. An APT 5-444 Powercenter was installed and a Trace 4024 sine wave inverter powers all the ac needs of the Ranch. Two Sun Frost RF-16 refrigerators are run off of the 24 VDC battery bank. A 35 Amp low battery cut-out in the power center protects the batteries from the Sun Frost loads. That's also a very good incentive for the caretakers to keep the batteries at their proper charge level!

Other than fine tuning, we finished the project the first week of July, 1996. The new system has only been up and running a short time, but so far it's doing nicely.

Why have the 12 Volt DC system?
Most of the 12 VDC wiring and light fixtures were already in. We did replace some of it and the distribution centers were brought up to code. There are a lot of 12 VDC loads and some, like the communications center, are on 24 hours every day. It was felt it would be a lot more efficient not to have the inverter on constantly. The same reasoning was applied

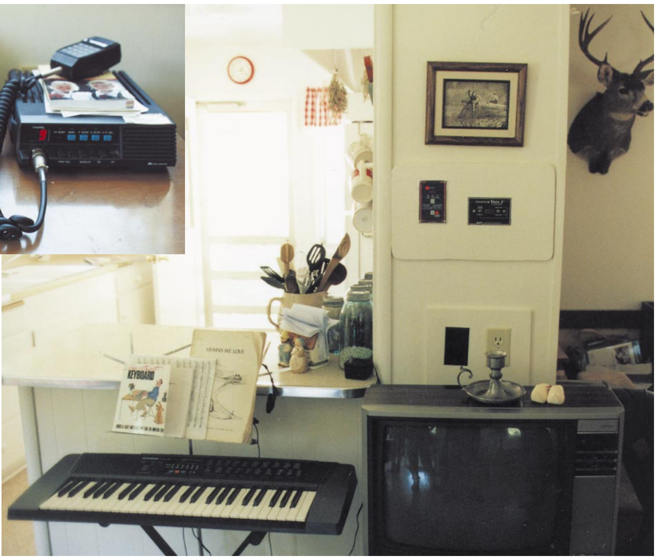
The Rogue River Ranch 24 Volt System



to having the Sun Frost refrigerators at 24 VDC vs 120 vac. Plus, what if the inverter broke down? There is also a completely separate lighting system with the 12 VDC that was kept from the old system. The 12 VDC lighting is used the most and takes a lot of pressure off the 24 VDC system by not going through the inverter. There are small 12 VDC lights above the beds to read at night. It wouldn't be very efficient to have to have an inverter on just to power them. If most the wiring and fixtures for the 12 VDC system weren't already in I'd probably not put one in again, but I'm sure glad it's there!

What the two systems are powering

Power is supplied to most of the buildings at the ranch. The caretakers house, the main house, crew quarters and shop have most of the loads. The communications system, fuel tank pump, and irrigation system are all powered by the renewable energy system. I estimate that the appliances powered by the 12 Volt system



Above Left: Two VHF radios are the Rush's connection to the outside world and the BLM.

Above: The large system easily powers TV, VCR, organ, and other luxuries.

Other BLM Renewable Energy Projects:

The BLM administers what's left of U.S.A.'s once vast land holdings that have not been passed on to other individuals, industries, states, or federal agencies. This amounts to over 272 million acres. It also manages mineral estate under an additional 300 million acres that are owned or administered by other agencies or private interests.

PV has been used for many years at remote BLM facilities, but it wasn't until April 1995, that the "Renew the Public Lands" partnership was forged with Sandia National Laboratories' Photovoltaics Systems Assistance Center. The goals were to survey existing PV uses, identify barriers to expanded use, and identify potential new opportunities within the BLM.

Partnership cost-share funds were made available for pilot projects that would expand BLM's familiarity and experience with PV technology. Here's a list of projects in addition to the Rogue River Ranch Project.

Sand Wash Ranger Station, on the Green River, Desolation Canyon, Utah - Electrify residence and 12 VDC communications at the contact station. 1.4 kW array, 3600 Ah battery, 1500 w inverter, and propane backup generator.

Ward Jarman's South Camp Cabin, Book Cliffs, Utah - Electrify remote administrative site. 330 W array, 530 Ah battery, 1500 w inverter, and propane backup generator.

Kane Gulch Visitor Contact Station, Cedar Mesa in San Juan County, Utah - Electrify visitor station. 1.4 kW tracking array, 3600 Ah battery, 4 kw sine wave inverter, propane backup generator. Batteries are in an underground concrete vault to help reduce performance impact from extreme temperatures.

Hickison Petroglyphs, near Austin, Texas - Provide drinking water from existing well to visitors. System to include a PV powered pump, no specs available.

Burro Creek Campground, near Kingman, Arizona - Light restrooms and pump water with PV, provide electricity for campground host with portable PV system. No specs available.

Hobo Camp, Westwood, California (near Susanville) - portable PV system for host camp. 380 W array, 480 Ah battery, 800 w inverter, all on a trailer.

Mine Shaft Spring, Butte District, Montana - PV power pumps water from mine shaft to storage tank and stock troughs. No specs available.

Portable PV Systems, 13 scattered through Arizona, California, Colorado, New Mexico, Oregon, and Utah - 1 kWh per day for basic ac electrical needs. No further specs available.

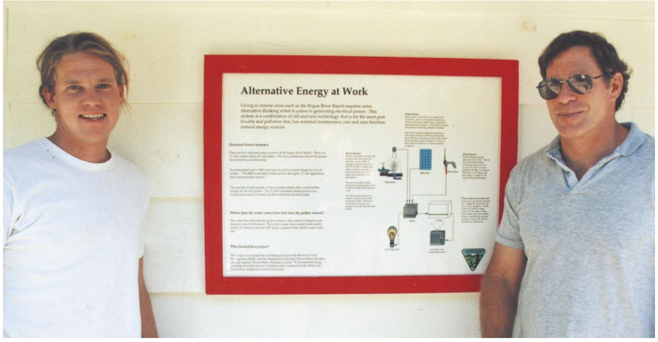
Powder River Basin, Casper District, Wyoming - early warning system for possible adverse effects of coal bed methane production, data logging at 7 stations. Small PV systems, no other specs available. Nine more stations planned.

Cottonwood Creek, Natrona County, Wyoming - watershed monitoring of grazing impacts, powering data loggers and radio telemetry. 8 small PV systems, no specs available.

Rogue River Ranch RE System Upgrade Cost

Quan	Material	Cost
12	Solarex MSX-83 PV Modules	$5,412
2	Sun Frost RF-12 Frig/Freezers	$4,306
1	Trace SW4024 Inverter	$2,331
	Cable & Wire	$2,179
12	Trojan L-16 Batteries	$2,091
1	Power Shed Construction	$2,000
	Conduit, Connectors, Hardware	$1,500
1	Ananda Power Center	$1,178
1	Harris Hyro	$1,000
27	Misc. Low Voltage Lights	$542
1	Air 303 Wind Generator	$441
1	APT -TDR1224A Regulator	$431
2	Pole Mounts for MSX-83 PV Modules	$400
1	APT-TDR312A Regulator 12V Hydro	$236
16	15 Amp DC Circuit Breakers	$225
1	Pole Mount for M55 PV Modules	$217
1	APT-DCLC60 60A Disconnect 12 V	$211
1	Alternator for 12 VDC Hydro	$200
3	Combiner Boxes for Sub Arrays	$180
2	12VDC Distribution boxes	$180
6	Polaris IT250 Connector Blocks	$168
1	Vista 3-SH Meter w/2 Shunts	$130
1	TriMetric Meter	$122
1	60A 2 pole Fused Disconnect 12V	$120
13	Battery Cables	$104
2	Trace BC10 Inverter Cables	$101
2	15A Breakers and Boxes at Sun Frosts	$90
2	30A 2 pole Fused Disconnects	$75
1	Vista 3 Meter	$74
1	LBCO35 35A Low V Disconnect	$74
2	LA100V Lightning Arrestors	$70
2	Trace BC5 Inverter Cables	$60
1	Combiner Box 2@#4 to 2@#4/0	$60
1	Conduit Box for SW4024 Inverter	$53
1	APT-ACS AC section for APT P/C	$52
2	LB15 15A Breakers-Sun Frosts P/C	$44
1	RMBT Remote Meter Terminal Block	$34
1	IB60 60A Breaker for Hydro/Wind	$27
1	ACB60 60A Breaker for AC Loads	$27
1	BCT-10 Battery Temp Sensor	$22
1	A60P-30A Input Breaker	$21
	Total	$26,788

Some components were purchased as GSA Contract items, while others were purchased on the open market. Some of the 12 VDC system components were purchased years ago and reused on this project. These include the Siemens M55 PV modules, one TriMetric meter, the SCI controller, and four Trojan L-16 batteries.



Above: Jason Minikin and John Bethea masterminded, convinced the Feds, and made it happen!

consume about 850 Watt-hours per day. The energy consumption for the larger 24 Volt system is about 6,300 Watt-hours per day.

The ranch's extensive irrigation system operates every other hour for a total of 12 hours per day. This system is powered by 12 VDC and 24 vac (via the inverter) and consumes about 96 Watt-hours daily. A Photocomm SIPS controller, a Hardie Irrigation TC-2400 controller and eleven Weathermatic 8000 CR solenoid operated valves are used in this irrigation system.

There is a large 3-phase 240 vac propane generator to operate a centrifugal pump in case of extreme fire fighting needs and a smaller 4000 watt propane generator as a domestic backup. My guess is the propane generators will only be run every once in awhile just to keep them lubricated. Just what I've been wanting all along!

Comments from Laura and Loren Rush

This is our fourth year as volunteers at the Ranch. Our new renewable power system has greatly improved our comfort and ability to enjoy some of the "creature comforts" we couldn't have before. One of the great enjoyments is the ability to run our fans for cooling during the hot summers. The new Sun Frost refrigerators allow us to keep vegetables for at least a week longer. We only shop once a month so this is a great benefit to us. It is great not to have to run noisy generators or worry about consuming fuel, constant maintenance, and repair. We are using appliances including the automatic washer as if we lived in the city. It's a great boon to isolated country dwellers.

Access

Author: John Bethea, Medford District Office, Bureau of Land Management, 3040 Biddle Road, Medford, OR 97504 • 541-770-2246 • FAX 541-770-2400

TRACE ENGINEERING

full page, bled

four color on negatives

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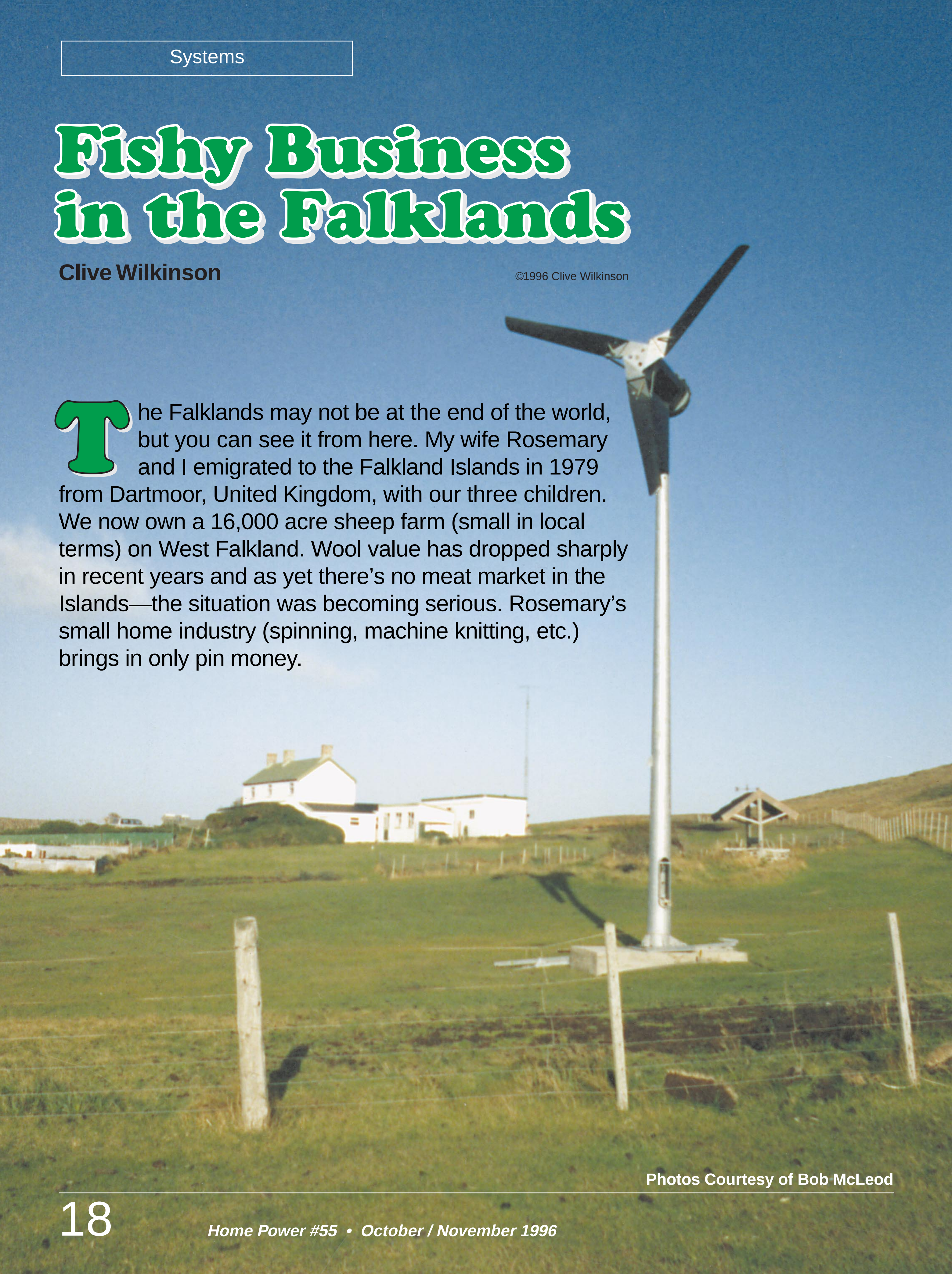
Fishy Business in the Falklands

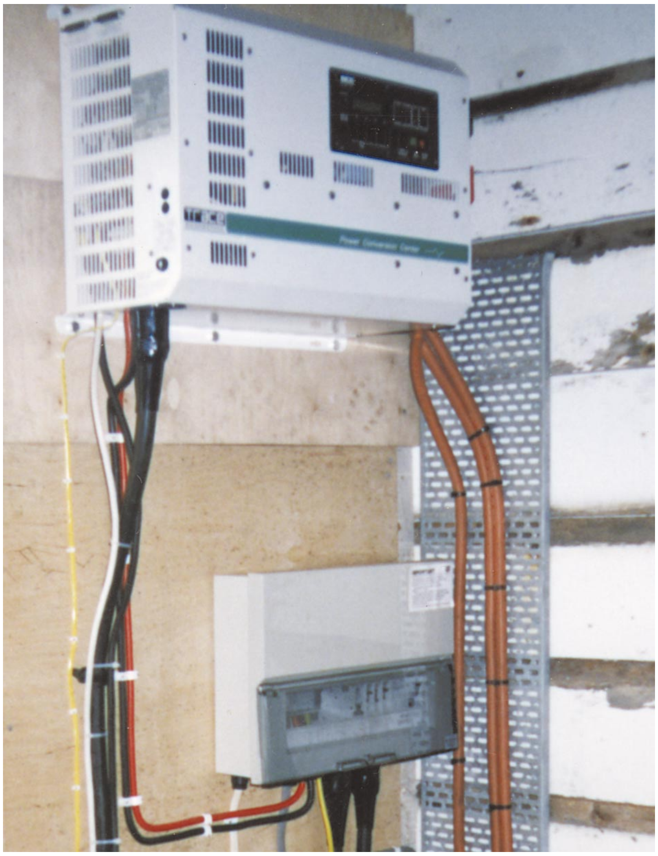
Clive Wilkinson



The Falklands may not be at the end of the world, but you can see it from here. My wife Rosemary and I emigrated to the Falkland Islands in 1979 from Dartmoor, United Kingdom, with our three children. We now own a 16,000 acre sheep farm (small in local terms) on West Falkland. Wool value has dropped sharply in recent years and as yet there's no meat market in the Islands—the situation was becoming serious. Rosemary's small home industry (spinning, machine knitting, etc.) brings in only pin money.

Photos Courtesy of Bob McLeod

Thus was born our new business, PowerSense, as a logical diversification. This is a country where wind is a constant companion but barely used resource. We've had our own 24 hour power system in use for six years and I felt others would benefit from a local supply and installation service. I'd had to do things myself, learning the hard way what equipment really worked and how to install and maintain it. This experience was backed up by an invaluable training period with Bob-O Schultze of Electron Connection.



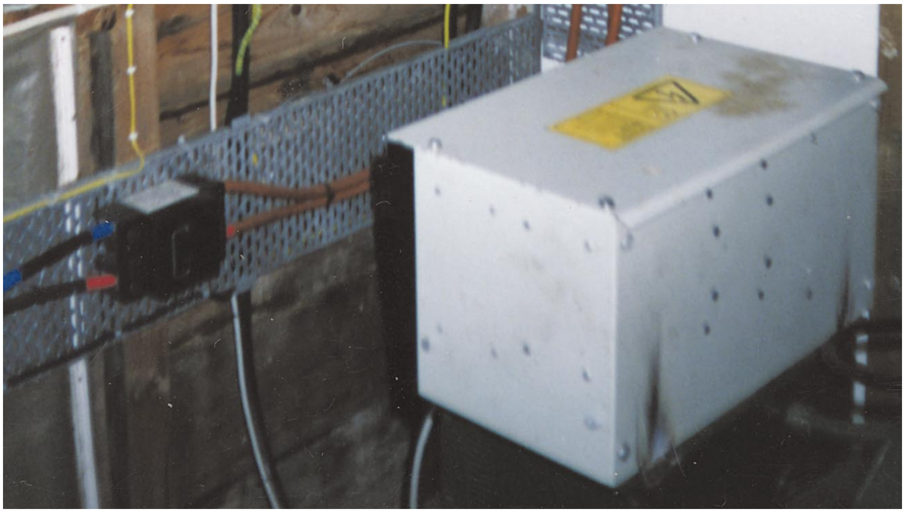
Above: A 3 KW Trace inverter operates at 240 volt, 50 Hz.

The Country

Situated some 300 miles off the coast of South America, the Falklands consist of two main islands plus over 300 smaller ones, almost all uninhabited. Around 4,700 sq. miles in total, the islands boast a permanent civilian population of around 2000. The majority live in the only town on East Falkland and therefore, the capital, Stanley. The remaining 500 or so are involved in sheep farming and/or tourism (on a miniscule scale). They live in what is known as Camp (i.e. anywhere outside Stanley) and are known as Campers. There is also a military presence of unknown strength at RAF Mount Pleasant, due to the ongoing sovereignty claims on the Islands by Argentina.

The Falklands are virtually treeless and covered in undulating moorland, ideal for sheep grazing. Much of the country is less than 300 feet above sea level though there are also many small hills and "mountains", the highest being 2,300 feet. Most settlements are by the sea for ease of transportation for wool, fuel, and stores. Houses are mostly of basic wood frame construction clad with flat iron and roofed with corrugated iron. Campers have to be self sufficient, baking their own bread, growing vegetables, milking house cows, etc. Television arrived a few years ago, though, and expectations are gradually altering. We have an excellent health service, free of charges, with a "flying doctor" service and even a travelling dentist.

Below: Genset control box and pullout style fused disconnect.



Originally this was a country of large farms often owned by absentee landlords and employing large shepherd gangs, navvies, etc. Horses were used until recently for all shepherding work. In 1979, however, the Islands' government began a process of subdivision. As a result most farms are now comparatively small and all are owner occupied. There's now a radio telephone system, a hybrid VHF and microwave system which is far from satisfactory as anyone who's tried to fax me will know to their cost. This is an expensive service, but vital. Loneliness is a very real problem for the more isolated farms.

The Islands' economy was originally based on wool, but is currently reliant on fishing revenue. Oil is being sought, with the prospect of

Above: Friends and neighbors gather for the raising of the 6.5 meter tower.

Left: The Proven ECM charge controller above the batteries and Lister ST2 gen set.

exploitation should a worthwhile resource be confirmed. As yet this is a distant dream and not all Islanders are ecstatic at the thought of a possible bonanza. The local wildlife is spectacular and could be threatened should oil take over as the main earner.

The Islanders are British to the hilt, talking of Britain as "home" even when the speaker has never left the Falklands! This is a young country, having been settled in 1833. Long distance travel is by the Government Air Service using Britten-Norman Islander aircraft landing on grass strips located at virtually every farm. Roads are still a novelty on East Falkland, with many miles yet to build if all farms are to be linked. West Falkland has only a short stretch of singe-track "road," really only a glorified farm track, linking three of the largest settlements. Our own farm is very remote. It takes us three hours cross country in our Ibex 4 by 4 to reach the nearest point (about 28 miles) of this "road."

Therefore, our main supplies come in by sea, including fuel so our battery/inverter system is invaluable in saving costs. There is no national grid. Farms have their own gensets and a few have already discovered the benefits of 24 hour power. PowerSense has several satisfied customers to date, with much interest being shown by other Campers.

The Customer

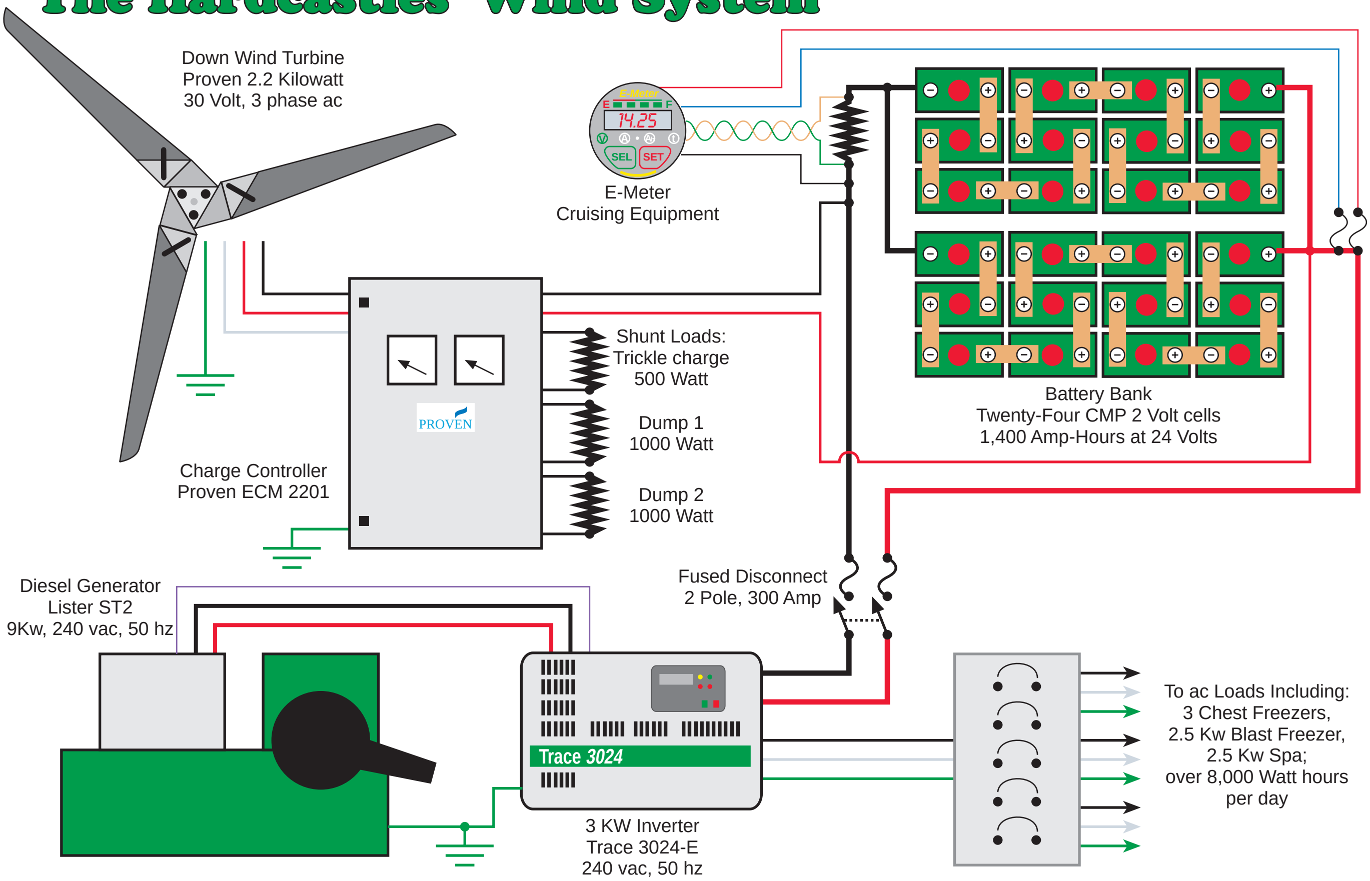
One such satisfied customer is based on East Falkland. Brook and Eileen Hardcastle retired to Darwin Harbour after a lifetime managing a massive sheep farm for the Falkland Islands Company. Never ones to sit around twiddling their thumbs, the Hardcastles set to and competently renovated their retirement home and gardens. Expert craftsmen both, especially at hand spinning, they nevertheless found time on their hands and took over their son's small fish processing business producing fresh and smoked fish for the local market. This had been insufficient to make a full time living for him, and he was leaving for the UK where he is now managing a commercially sized fish farm.

At first the Hardcastles were content to rely on their 9 kw Lister genset to provide power for their home and business, including the demands of storage and blast freezers, normal household appliances, a spa bath, etc. But then they started talking to farmers who'd purchased battery/inverter systems… In his own words, Brook decided to "Go for it!"

Sizing the System

I consequently received an enthusiastic phone call in which Brook outlined his energy requirements, including

The Hardcastles' Wind System



three 15 cu. ft. freezers for fish storage and some energy-hungry household appliances plus lighting, etc. The total daily energy requirements added up to over 8000 watt-hours. Added to this, the Hardcastles had their 2.5 kw spa bath (much appreciated after a typical day's "retirement!") and a 2.5 kw blast freezer for pre-freezing the fish for optimum condition.

Brook thought he'd eventually want to buy a suitable wind turbine but initially he just sought an inverter/battery package to provide 24 hour power with the existing generator's running hours. I therefore proposed a two-phase project. The first stage would involve installing a Trace 3024E inverter/charger together with a 700 Amp hour 24 Volt Chloride Motive Power battery. Together these would service the household loads outside normal genset operating hours (2 hours in the a.m. and 4 to 6 hours in the p.m., depending on the time of year). Heavy loads would be restricted to the genset running hours with timers used on the three freezers, these being left on the Fast Freeze setting.

Phase two of the Darwin project was to be the future installation of a wind turbine to reduce genset running time to a minimum.

Phase One - Installation

In September 1995, I flew across to Darwin where I met up with our son Alistair. Together we set about the installation work. He worked on the wire runs whilst I filled the battery which had been manufactured to order in the UK and shipped out dry-charged for safety. The CMP battery used is a lead acid traction battery comprising twelve 2 Volt cells pre-assembled in a plastic tray. All inter-cell connectors are insulated with snap-on plastic shrouds. The battery came complete with cable, rubber gloves, eye protectors, hydrometer, and a comprehensive user's guide. It has a 1500 cycle to 80% D.O.D. life and is rated at 700 Ah at 10 hours.

The Trace 3024 had also arrived, courtesy of Bob-O, by air to UK and then by sea. Logistics are a real problem when you live near the end of the world.

The Trace 3024E has a continuous power rating of 3 kw at 234 vac and 50 hz. It has proven ideal for domestic use in the Falklands and I was confident in its reliability. The battery cable is 95 sq. mm. mounted on cable racking in free air with a 300 Ampere, 2 pole, fused disconnect and the E-Meter shunt between the battery bank and inverter. Cable for ac input from the genset to inverter is double insulated 16 sq. mm., with the same

for the output from the inverter to consumer unit (60 amp RCD with 300 ma tripping current).

The Genset

The existing generator is a Lister ST2, air cooled, 2 cylinder, electric start diesel engine. It runs at 1500 rpm and is close-coupled to a Stamford brushless alternator with a rated output of 9 kw at 240 vac and 50 hz. Regulation is via an AVR which maintains output voltage to within ±5% of nominal. Failsafe features include shutdown for low oil pressure, high temperature, and high or low voltage. Output is via a relay which activates once voltage is stable, and the output is through a 50 amp circuit breaker.

Auto Stop/Start

I set the Trace's generator auto stop/start function to start at 22.5 V low battery or 20 amps ac after 2 minutes. A 2.5 sq. mm. 3 core signal cable is connected from Comm. to the 12 V power point, fused at 5 Amps. Relay 8 is connected to the fuel contact and Relay 7 to the starter contact in the generator control box. (NB: Generator control boards differ. You soon know if you have connected up wrong—the generator will not start and the starter will not stop!

Into Hot Water

On testing the system, the Trace 3024E was happily powering the spa bath on its maximum setting of 2.5 kw, as well as 750 watts of freezer load AND a further 600 watts from household appliances. So we added a few more watts, taking the load up to 5 kw, and after two minutes the genset fired up and stayed on for 30 minutes! Great, we had a fully working automatic system!

Time for Spreading the Load

Because the freezer load is high, Brook added a timer to each of the three storage freezers. Bob and Janet McLeod, Brook and Eileen's son in law and daughter, set each appliance to run on thermostat for 6 hours in every 24, staggering the settings so that only one freezer would be running at any time.

With the charge rate set at 15 amps ac (75 Amps DC) and the bulk Volts at 28.8, the genset run time was cut from 8 hours to 5. The Hardcastles had discovered the joys of 24 hour power! Brook got really keen then and decided not to wait, but to go ahead with Phase Two—the wind turbine.

Left: A view from downwind of the Proven WT 2200 wind generator, 2200 Watts at 13 meters per second.

Choosing a Turbine

With a mean wind speed of 9 m/sec and gusts of 60 to 80 knots in 30 to 50 knot winds, respectively, The Falkland Islands offer the ultimate environment for testing wind turbines. Armed with sufficient data on dominant wind direction, power density, and wind speed patterns collated from various wind sites, I was able to work out an estimate of energy output. I have also learned, the hard way, that lightweight, high rpm turbines do not last. Worst case scenario to date is 12 hours! The best so far, 6 months. This is an environment for "heavy metal," low rpm machines.

When advising Brook, I looked at survivability, output at 6 m/sec (the lowest monthly average), power curve, and cost. In that order. The turbine had to be able to reach rated output at a reasonable wind speed and rpm and generate power when others would have decreased output to a trickle charge. We chose the Scottish built Proven WT 2200, which was duly ordered. There followed the inevitable delay due to being over 8000 miles from the source.

A Mean Machine

The Proven WT 2200 has a rated output of 2.2 kW at 13 m/sec with a nominal rotor speed of 300 rpm (the Proven WT 2200 has since been upgraded to a 2.5 kW rating without an increase in price). Output at 9 m/sec is

1130 Watts (47 Amps at 24 Volts). At 6 m/sec the output is 600 Watts (25 Amps at 24 Volts). The WT 2200 is downwind 3-bladed turbine with a rotor diameter of 3.4 m. A strong spring is attached between the hub and the back of each blade, allowing the polypropylene blades to bend and twist in high winds. The P. M. alternator generates 3-phase output, nominal 30 volts, and a maximum of 90 amps (60 amps per phase) at 20 hz. The standard Proven tower is multi-faced galvanised steel, free standing, and 6.5 m high. It comes complete with a hinged base plate and gin pole and is designed to stand on a 1 cu. m. reinforced concrete foundation (35 Newtons strength). The top-of-tower weight is 190 kg and the lateral force that the tower has to withstand is 5000 Newtons at hub height.

Installation of the Proven drew quite a crowd of interested onlookers/helpers, including passing Cable & Wireless personnel. Almost like a barn-raising! Located 100 m. from the battery bank, the turbine supplies power via a 3 core 50 sq. m. cable to the ECM 2201 controller box. This box houses a 3 pole CB, 3-phase rectifier and 5-stage control unit for load diverting. Each stage is controlled by a bi-stable switch with an adjustable on/off gap.

I adjusted the gap settings so that when the battery voltage reaches 29 V, a 1 kW (at 24 V) heat element switches on in the Hardcastles' sitting room. Should the voltage reach 30 V, a second 1 kW element switches on. Both elements switch off in sequence as the battery Volts decrease. A diode in the circuitry prevents the battery from cycling when energy is being diverted to the heat sinks. In storm conditions or if the heating loads are lost, the main charge contactor opens and output is fed as a trickle charge through a 500 Watt, 24 Volt, heater/resistor. In emergency conditions the trickle charge contactor opens and no power output from the turbine is allowed. The turbine then runs free up to its maximum speed, when the blades will turn and stall to control the speed. Having said which, in such windy conditions the Hardcastles are likely to enjoy an extra session in their spa bath to use up the power… who needs heat sinks?!

Results To Date

Brook reports that the diesel generator runs for about 1 1/2 hours a day, but has gone as long as 10 days without starting up. In fact, the only time the genset is required is for the spa bath on calm days! He has replaced one of the energy-hungry freezers with a Danish made Elcold energy efficient model.

A second 700 Ah battery was added to the system in July, enabling the battery bank to cycle at 30 to 40% D.O.D. instead of 50 to 60%. Brook and Eileen are delighted with their system, and since a satisfied customer is the best advert of all, I am happy too. I appreciated their hospitality during the work. They serve a mean drink and I miss using the famous spa! I was grateful to son Alistair for checking the existing ac wiring throughout the house plus his general help. (He is now away in the UK studying electrical engineering.)

The Way Forward

RE is not new to the Falklands since many Campers used Windcharger generators for lights and battery chargers for radios from the thirties to late fifties. In fact, there's an elderly Lucas charger still working to this day (who said "Only dim and off!"?). But modern systems are the way to go and there is considerable interest among fellow farmers. Thanks to Bob-O's patient training of me and his excellent distributor back-up, I'm confident I can offer a good service to the Islands through PowerSense. I've just got to pacify the Missus, who's demanding her very own 3024E, mega battery bank, and Proven charger … like yesterday! I keep telling her there's nothing wrong with our good old Trace 2012ESB. It has run continuously for six years without a hiccup. No, I tell a lie — it was off for 15 minutes while I added an E-Meter shunt to the line.

Cheers, folks, I look forward to updating you on the Falklands RE scene in due course.

Access

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The Sol of Cuba

Laurie Stone

Cuba, a small Caribbean island only 90 miles off the coast of Florida, has miraculously survived decades of U.S. aggression. Not only has Cuba survived, but it has risen out of its "third world" status in its determination to develop in a sustainable way.

I went to Cuba with Global Exchange, a non-profit organization that organizes "reality tours" of Cuba. The tour coincided with an international solar energy conference organized by CubaSolar, a non-governmental Cuban organization. Having worked on numerous solar energy projects in Central America, I went to Cuba with the misconception that I could use my renewable energy technology transfer skills there. However, I quickly learned that the last thing this country of 11 million people needs is technical assistance. In the middle of an economic crisis and struggling against a U.S. trade embargo, Cubans have advanced far past anything I would have ever imagined.

Cuba's Energy History

Until 1960, Cuba's electricity was based on petroleum and was mostly for large cities and tourist places. The majority of rural areas had no electricity. The whole country was surviving on barely 800 MW. The revolution of 1959 led to a big push for rural electrification. By 1989, 96% of the country was electrified, with over 3000 MW. However, Cuba was importing most of its petroleum from the socialist bloc at low prices. In 1989, with the falling of the socialist bloc, Cuba could not afford to buy petroleum on the international market. They had been using 4 million tons of petroleum per year for electricity for houses. This had to be cut down to 2 million. The need to reduce their energy usage by 50% led to an extreme revamping of their energy plan and a huge push for renewable energy.

Energy, Sweet Energy

Sugar is the heart of Cuba's renewable energy program. Sugarcane, Cuba's main export crop, is supplying almost 30% of the energy used in Cuba. After the cane is harvested, the residue (bagasse) is used to power the whole processing plant. They then sell the excess electricity back to the grid. There are 156 sugar mills in Cuba. They each produce 20 to 80 kWh/ton of bagasse. They are also compressing the waste parts of the plant, such as the leaves and the stalk, to be used as a solid fuel.

Energy from Cuba's Rivers

The second most important renewable energy source in Cuba is micro-hydro power. Cuba is not blessed with many large rivers, but it does have a lot of small rivers. This turns out to be a great advantage. They have not had the chance to create the massive destruction of

Right: A micro-hydro powered community in Guama, a mountainous province of Cuba.

Below: The 30 kW hydro system in Guama.

large dams as the U.S. has, but have installed over 220 micro-hydro systems supplying 30,000 Cubans with electricity. Right now they are generating 55 MW from hydro sites, with an annual generation of 80 GWh. Some of the systems are used to provide electricity to remote regions without the grid, and other systems are used to sell electricity back into the grid. The systems range from 8 kW up to 500 kW.

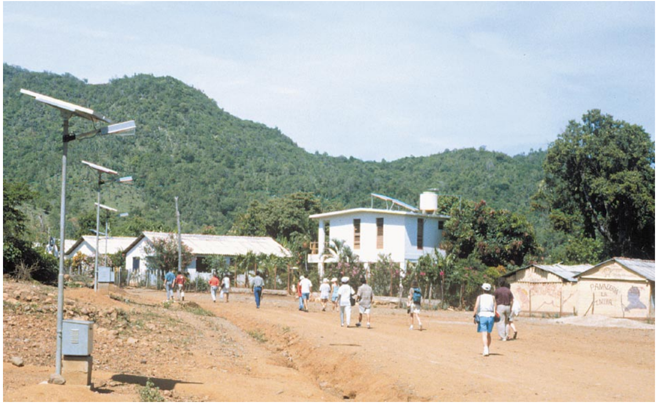
One of the towns we visited in Guama, a province with 30 micro-hydro plants, has a 30 kW system. The system provides electricity for the 250 people living in 56 houses. Each house is limited to 100 watts, and the entire community is only using 10 kW. They eventually want to send their excess electricity to the next town over, which is 4 kilometers away, and is also not connected to the grid. Four people operate the system, each working six hours per day. They make sure the output of the hydro system meets the demand of the community. The people in the town only need to pay a small fee to cover the salaries of the four operators.

The "Sol" of Cuba

We also had the chance to visit a beautiful town in the mountains called Magdalena. Magdalena is off the grid as well, and is completely powered by photovoltaics. The community has a population of 574. Each house has its own 70 Watt PV system to run compact fluorescent DC lights, radio, and television. The houses each have 18 lighting hours per day. There are 11 Watt PV street lights lining the street. There is also a 3 kW PV powered water pumping system which pumps 30,000 gallons of water per day for the entire community. The community center has an inverter to run ac appliances, and the doctor's office has a larger 8 panel system with a PV powered vaccine refrigerator.

Throughout Cuba, there are 295 PV powered rural homes, three community systems averaging 2500 peak Watts each, and over 50 PV powered doctor offices. They are manufacturing their own charge controllers, have developed a sine wave inverter, and are making their own modules from imported cells. They hope to soon manufacture their own PV cells as well.

The majority of the problems with PV systems have been related to the tropical conditions of the Cuban climate. Most of the installed equipment was not designed for tropical conditions. Therefore, the Center for Solar Energy Research (CIES) in Santiago de Cuba has a research lab to test the performance of solar



Above: Magdalena, a PV powered community — street lights and all.

equipment in a tropical climate. They hope to be the central research and information center for tropical PV research in the entire Latin American and Caribbean region.

A "Cool" Greenhouse

The intense Cuban heat also poses some problems for agriculture. While we have greenhouses so we can grow summer crops in the winter, the Cubans have devised a reverse greenhouse, so they can grow winter crops in the summer. The reverse greenhouse is a small room with a flat glass roof. There is a layer of water on the roof, which blocks the infrared (IR) radiation from entering. The water is colored, the exact tint needed to block the IR, and they can vary the amount of radiation entering the greenhouse by varying the amount of water in the roof tank. They also pump this water through tubes in the greenhouse and mist the plants with it to help it cool off more. They have basically eliminated the need for any back-up cooling to grow plants in the heat of the summer.

Wind Power

Wind energy is also happening in Cuba. There are over 9000 wind mills pumping water in Cuba, and many small wind generators under 1 kW. The majority of wind mills and turbines are made in Cuba. They are currently studying 17 sites with the possibility of installing large wind turbines and wind farms to provide electricity to the grid. In September, Cuba will begin construction of a 1 MW demonstration grid-connected wind farm.

Cuba is also investigating the use of wind/PV and wind/diesel hybrid systems. A German designed wind/diesel hybrid system has recently been proposed for a tourist hotel. The system includes a 45 kW wind generator, and two diesel gensets with capacities of 25 and 32 kW. The site has an average wind speed of 7 m/s, and the projected output of the system is 5.8 kWh/m/day.

Solar Sisters

I cannot write about the energy program in Cuba without mentioning Cuban women. Women are integrated into every aspect of Cuban society. Over 50% of the doctors and 55% of all scientific professionals are women. I realized how far we still need to go in the U.S. when we visited a 40 kW micro-hydro site in Jagueyon. I found myself being shocked that the entire operation was run by two women. Although I have been in the engineering field for years, and have tried to integrate more women into the science and engineering field, it is a much more common sight to see women technicians and engineers in Cuba than in our "developed" nation.

Above: The 3 kW PV water pumping system for the community of Magdalena.

In fact, not long ago, 75% of the people passing the entrance exams to enter science and technology universities were women. The Cuban government had to implement an affirmative action program that lowered the necessary test scores for men to even out the gender gap. Now women make up 60% of the students in the science and technology universities.

Cuba's Future Generations

We also cannot forget the young people of Cuba. Renewable energy and the environment are big parts of the Cuban education system, from primary schools through the university level. All high schools teach renewable energy in their curriculum and some of them have renewable energy equipment at the school.

We visited the Che Guevara Technical High School in Havana. There are 500 students (over 300 of them women) and the school uses a solar oven, solar water heaters, PV modules, and wind turbines. Although the school is not specifically geared towards renewable energy, every class includes a renewable energy component. In biology class they learn how to build a biogas plant. In physics they learn how a solar panel

Left: Don Coan and Barbara Jodry from Solar Cookers International displaying a solar panel cooker at the CubaSolar conference.

Right: A Cuban manufactured wind turbine.

works. They also have an energy-efficient wood-burning stove which cooks the meals for the students during the week. This is the same type of stove that is implemented in over 250 schools throughout Cuba.

It amazed me how far Cuba has advanced in the face of severe shortages. The economic crisis and the U.S. trade embargo have made electricity blackouts and shortages of food, soap, and toilet paper a fact of daily life. Yet the determination to develop in a sustainable way has led the Cubans on an impressive renewable energy path, in spite of the lack of materials, computers, and money.

Although I brought a lot to Cuba in the form of humanitarian aid such as medicine and renewable energy books, I feel I came away with much more. I learned many things from the Cuban people. I realized that ending the trade embargo is crucial not only to allow Cuba to receive much needed materials, but also to allow us to learn from their accomplishments. I also learned that sustainable development is not so much an economic issue as a political issue. If a country truly wants to develop in a sustainable way, it can improve people's quality of life no matter what the GNP. And Cuba's accomplishments in the field of renewable energy proves it.

Access

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Left: Members of our group in front of a mural in Havana, which says, "The sun is being fined for shining on Cuba."

ANANDA POWER TECHNOLOGIES

full page, bled
four color on film

this is page 31

Electric-Powered Hydraulic Log Splitter

Matt Armstrong

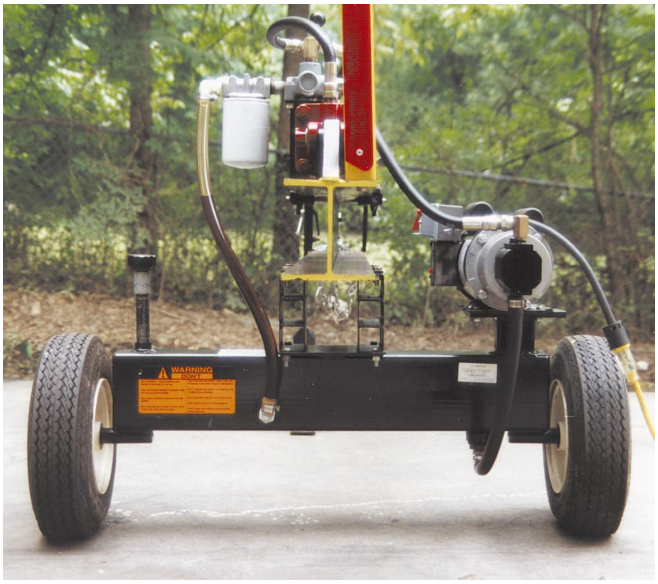
Above: Matt Armstrong's converted electric / hydraulic log splitter ready to...split.

We bought a 5 hp gasoline engine powered hydraulic log splitter (1150-C086) at Northern Hydraulics' store in Marietta, Georgia. It is a horizontal only splitter, the cheapest one they had.

We split Georgia red oak for firewood to sell. As you can imagine, the noise of the engine was about to drive us bonkers. Even with high quality ear protectors, the noise was bad due to its low frequency content, which ear protectors don't attenuate.

After considering welding a car muffler onto the 5 hp engine, we thought it would be more fun to convert it to electric.

Looking at Northern Hydraulics' catalog, we found the following two equations: 1 hp electric motor = 1.5 hp hydraulic motor and 1 hp hydraulic motor = 1 2/3 hp gasoline engine.



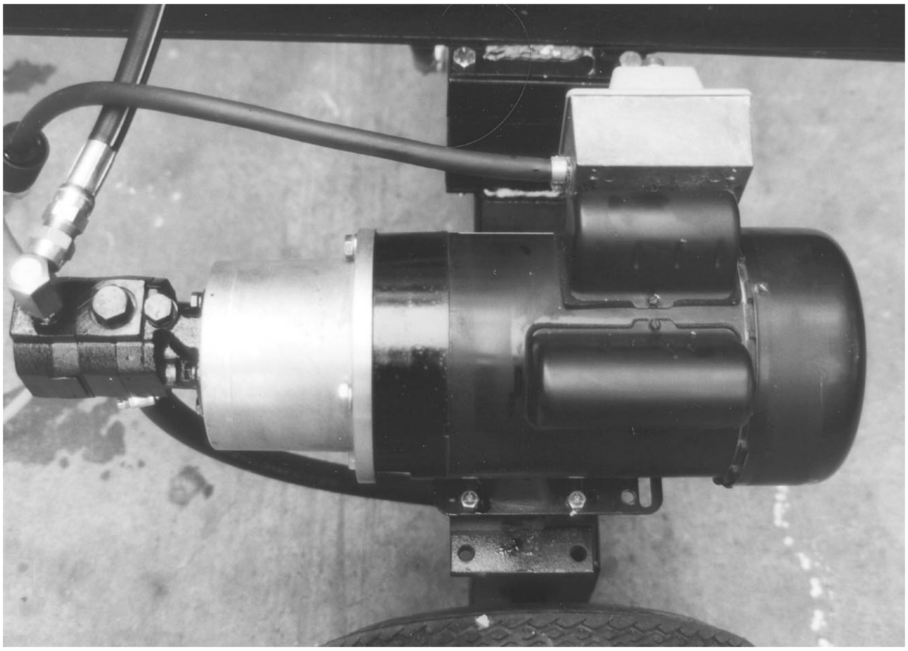
Above: Quieter, cleaner, more powerful, less smelly, all-in-all a better tool.

To equate an electric motor to a gasoline engine, we multiplied 1.5 X 1 2/3 and got 2.5.

So a 1 hp electric motor = a 2.5 hp gasoline engine. Since the engine being replaced was a 5 hp gasoline engine, we needed a 2 hp electric motor.

A reasonably priced C-Face (56C frame) 2 hp, 230 volt motor (22109-C086) was found at Northern Hydraulics for $139.99. C-Face motors have a smooth machined ring on one end. Adapters fit onto this ring and are held on by bolts into tapped holes in the motor.

We found an adapter (6Z070) in the W.W. Grainger catalog for $28.15. This aluminum adapter matches up to the C-Face motor on one end. The other end matches up to the 4 bolt (4F17-4 bolt pattern) hydraulic pump. The motor and pump shafts project inside the adapter. There's a coupler on each shaft. Between the couplers is a star-shaped piece of rubber. This compensates for any slight misalignment.



Above: The 2 hp, 240 vac motor more than does the job.

The gasoline engine had a 3/4 inch shaft. The new electric motor had a 5/8 inch shaft. We had to buy half of a 5/8 inch coupler (3004-C086) from Northern Hydraulics for $6.59. The old rubber insert still worked OK since the only difference was the shaft diameter on one of the two couplers.

The motor is rated to draw 8.4 amps at full load at 230 volts. Wanting about 100 feet of wire on the splitter we bought a 12 gauge, 3 conductor extension cord from Home Depot. 12 gauge wire is rated for 20 amperes. There was plenty of excess capacity in the wire. However, the real question at 100 feet is voltage drop. Our calculations show an insignificant voltage drop.

We mounted a heavy duty 20 ampere switch from Home Depot on the splitter and attached the other end of the 100 foot extension cord to an electric clothes dryer plug. Clothes dryers are on a 30 ampere circuit, so there was plenty of capacity. Also, clothes dryer outlets are installed on every house around here. We knew we could take the splitter within 100 feet of any home and use it.

The electric motor operates at 3450 rpm. This is about the same speed as the gasoline engine at 3600 rpm. No changes were necessary here.

No hydraulic hoses needed to be changed. We didn't even remove them. We did raise the splitter up about six inches using several pieces of two inch box tubing. This is so we wouldn't have to lean down over the splitter. The electric motor was mounted onto the old gasoline engine mounting plate with four bolts.

Then we turned it on. Quite a bit of wood had been split before changing the engine to an electric motor so we were quite familiar with how the splitter felt and sounded when hitting knots. It was suprising to find that the electric motor seemed to have more power than the gasoline engine. Based on this, we probably could have gotten away with a 1.5 hp electric motor.

One thing we were not prepared for was the sound of the hydraulic pump. The noise of the gasoline engine had previously masked the hydraulic pump sound. A conversation can easily be carried on while splitting wood with the electric motor, however the hydraulic pump sound is somewhat irritating. We ended up wearing push-in foam ear plugs to attenuate the high frequency pump noise. These don't affect conversation at all.

We used to split wood well into the evening in our subdivision and frequently heard about it from the neighbors. After switching to electric, several neighbors asked us if we got rid of the log splitter.

As an acid test, we jammed the splitter ram into a sideways log to get the pump to max out. Then measured the voltage at the breaker panel and at the motor terminals. The loss was only about 3 volts. This

tiny voltage drop is well within motor design guidelines. When maxing out the pump, no audible speed drop in the motor was detected. We were amazed!

Since the splitter now feels like it has more power, we went one step further. Previously a horizontal wedge that slips over the top of the vertical wedge had been fabricated. This gives us four pieces of wood output instead of two and dramatically reduces splitting time. When this was used with the 5 hp gasoline engine, the engine's governor would really kick in to try and keep the engine speed up. We were worried that this might overload the electric motor. Not so. In fact, no difference in motor speed is noticeable at all. However, if we're splitting a 3 foot diameter log, we'll remove the 4-way splitter for the initial split.

Overall we much prefer the electric motor over the gasoline engine. The gasoline engine was sold for $100 recovering about half our cost. And we no longer have to fool with gasoline, oil, and cleaning the air filter.

Could a DC motor be used? Probably. I'd use a 24 VDC, 1 hp permanent magnet motor and just avoid logs with large knots.

Next project: A 24 VDC powered homemade go-cart.

Access

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W.W. Grainger Offices throughout the country and overseas. Call 800 directory assistance for the office nearest you.

Phantom Loads Update...

Michael P. Lamb

In the past I think that most of us have quietly laughed at the people who insisted on unplugging everything in the house when they are not in use. We thought that these folks were a little goofy. Now that you own an RE system these funny ideas are no longer so laughable. For a person living off the grid, phantom loads can become a very expensive nuisance.

As the table shows, the term "off" can be a relative one. This is a summation of tests conducted by me during January and February, 1996. The dollar amounts are based on the assumption that the appliances are always plugged in but never used. Any usage would obviously make the dollar amount higher. Also, I have not attempted to compensate the values on the list for power factor. Doing so would force me to go into a lengthy discussion of LRC circuit calculations, vector mathematics, and electron theory, subjects best avoided for this particular discussion.

Materials Needed

The following, except the multimeter and calculator, are needed to construct the Phantom Meter. This device is actually a simple shunt tester. Refer to the diagram for construction details.

- **Calculator**
- **Digital multimeter**
- **Duplex receptacle box and cover**
- **Duplex receptacle**
- **1000 ohm, 10%, 7 watt resistor (or any other close tolerance resistor)**
- **Small wirenut**
- **4 feet of lamp cord with male plug end**
- **Strain reliever for lamp cord into box**
- **Pair of electronic testing points**
- **Electric drill with 1/4 inch bit**

Test Procedure

1. Turn off the appliance to be tested with its factory switch.

2. Measure the resistance of the shunt resistor (the resistance may or may not be the same as its rated value). Write this number down, labeling as "ohms."

3. Unplug the appliance from the wall and insert its plug into the duplex receptacle on the tester box.

4. Plug the tester into the wall outlet.

5. Measure the ac voltage across the test points of the tester box. The measurement is the "shunt voltage." Write it down, labeling as "E-shunt."

Do this within the first minute of plugging everything in. If there is a large amount of phantom load associated with that appliance, the resistor can get quite warm, causing the resistance to change.

6. Unplug the tester from the wall and the appliance.

7. Measure the ac voltage from the two long slots in the wall receptacle. Do not assume it is 110 volts, the utility or inverter voltage can vary. Write this down, labeling it as "E-line."

The Mathematics

Divide the shunt voltage ("E-shunt" from step 5) by the value of the shunt resistor ("ohms" from step 2). Label the result "I". This is the current (amps) flowing through the resistor at the time of the test.

Phantom Electrical Loads

Appliance	Phantom Watts	Yearly kWh	Energy Cost in $ per Year Utility 8.5¢/kWh	PV 40¢/kWh	Wind 20¢/kWh	MicroHydro 5¢/kWh
13 inch BW TV '70	1.060	9.3	$0.79	$3.72	$1.86	$0.46
13 inch Color TV '92	2.260	19.8	$1.68	$7.92	$3.96	$0.99
14 inch Color TV '92	1.850	16.2	$1.38	$6.49	$3.24	$0.81
19 inch Color TV '76	0.504	4.4	$0.38	$1.77	$0.88	$0.22
19 inch Color TV '93	13.220	115.9	$9.85	$46.35	$23.18	$5.79
27 inch Color TV '94	13.060	114.5	$9.73	$45.79	$22.90	$5.72
Cookstove, Electronic Ignition	14.000	122.7	$10.43	$49.09	$24.54	$6.14
HVAC Thermostat	0.076	0.7	$0.06	$0.27	$0.13	$0.03
Video Cassette Recorder	14.000	122.7	$10.43	$49.09	$24.54	$6.14
Radio, 50 Years Old	0.118	1.0	$0.09	$0.41	$0.21	$0.05
Stereo Receiver, Analog	0.260	2.3	$0.19	$0.91	$0.46	$0.11
Stereo Receiver, Digital	3.700	32.4	$2.76	$12.97	$6.49	$1.62
Desk Lamp,120vac/12VDC	3.300	28.9	$2.46	$11.57	$5.79	$1.45
Microwave, Digital '94	2.700	23.7	$2.01	$9.47	$4.73	$1.18
Microwave, Analog '83	0.000	0.0	$0.00	$0.00	$0.00	$0.00
Microwave, Analog '73	0.040	0.4	$0.03	$0.14	$0.07	$0.02
Dimmer, Incandescent Lamp	0.019	0.2	$0.01	$0.07	$0.03	$0.01
Door Bell Transformer	2.200	19.3	$1.64	$7.71	$3.86	$0.96
NiCd Charger, No Batteries	1.700	14.9	$1.27	$5.96	$2.98	$0.75
Flashlight, Rechargeable	10.650	93.4	$7.94	$37.34	$18.67	$4.67
Wall Cubes for Electronics	5.000	43.8	$3.73	$17.53	$8.77	$2.19
Touch Lamp	2.300	20.2	$1.71	$8.06	$4.03	$1.01
Lamp Timer	2.300	20.2	$1.71	$8.06	$4.03	$1.01
GFCI Outlet	0.890	7.8	$0.66	$3.12	$1.56	$0.39
Refrigerator Power Saver	0.120	1.1	$0.09	$0.42	$0.21	$0.05
Computers & Office Equipment						
AST 80286	0.001	0.0	$0.00	$0.00	$0.00	$0.00
Generic 80386 CPU	0.001	0.0	$0.00	$0.00	$0.00	$0.00
Dell Ultrascan 15ES Monitor	1.400	12.3	$1.04	$4.91	$2.45	$0.61
Dell 486/Mxe CPU	3.400	29.8	$2.53	$11.92	$5.96	$1.49
Gateway2000 1024NI Monitor	0.210	1.8	$0.16	$0.74	$0.37	$0.09
Gateway2000 4SX33 CPU	1.500	13.1	$1.12	$5.26	$2.63	$0.66
Canon NP6650 II Copier	10.200	89.4	$7.60	$35.77	$17.88	$4.47
HP LaserJet 4 Printer	1.000	8.8	$0.75	$3.51	$1.75	$0.44

Many thanks to Home Energy Magazine for allowing us to reprint parts of this table.

If the appliance is really off, the shunt voltage will be 0. Ohm's Law tells us that if there is any voltage across a resistor, there is current flowing through it.

A very sensitive ammeter in series with the the resistor could do the same job, but the shunt device is safer to use, less expensive, and about as accurate.

Multiply "I" by the outlet's voltage ("e-line" from step 7). The new number will be the watts being consumed by the appliance under test. In other words, "E-line" X "I" = w. (This value is actually volt-amps (va), but for our purposes wattage and va are the same.) This is the amount of power that the appliance is using when it is "off."

How Much Money?

This will help you figure out how much each phantom load costs you per year, based on what your local utility charges for that energy. Of course, a home power system's owner would be financially impacted in other ways.

1. Estimate the number of hours per day that you do not use the appliance.
2. Multiply those hours by 365.25 days (one year).
3. Multiply the result by the watts calculated as above, giving you watt/hours.
4. Divide this new number by 1000 to convert it into kilowatt/hours (kWh).
5. Multiply the kWh by your electric rate. If you don't know your rate, your electric bill or the utility can tell you.
6. Scratch your head. By now you should be well versed with how arbitrary the term "off" is.

Hopefully your new phantom tester can help you pin point and quantify the elusive phantoms that haunt your system.

Access

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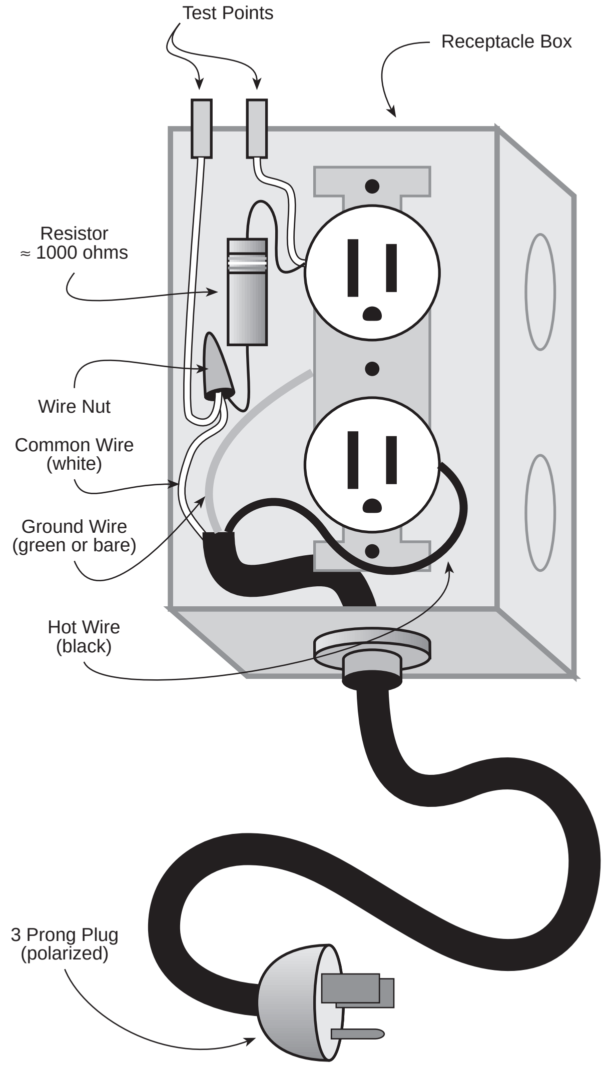
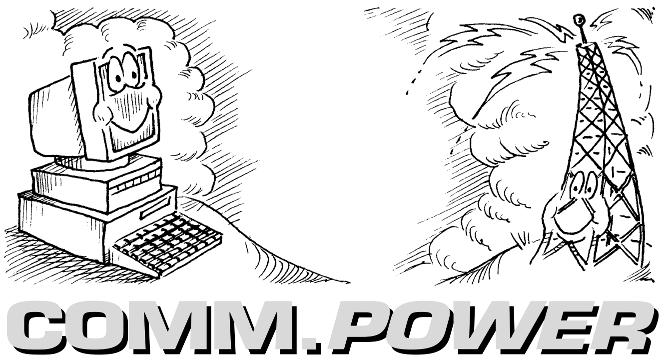
Energy Efficiency and Renewable Energy Clearinghouse • 800-363-3732



Estimated Energy Consumed by Phantom Loads in 100 Million American Households

Typical American Home's Phantom Loads	*Phantom watts*	*Hours per day*	*Number per household*	*kWh/year per household*	*% households 0wning*	*Millions of kWh per year*
Wall Cubes for Electronics	5.00	23	2	84.01	90%	7,561
Video Cassette Recorder	14.00	21	1	107.38	70%	7,517
19 inch Color TV	13.22	18	1	86.91	80%	6,953
Stove, Electronic Ignition	14.00	24	1	122.72	30%	3,682
Stereo Receiver	3.70	18	1	24.33	80%	1,946
GFCI Outlet	0.89	24	3	23.41	80%	1,872
Microwave	2.70	23	1	22.68	70%	1,588
Desk Lamp	3.30	22	1	26.52	20%	530
Computer	1.50	18	1	9.86	40%	394
NiCd Charger, No Batteries	1.70	23	1	14.28	20%	286
HVAC Thermostat	0.08	22	1	0.61	70%	43
Laser Printer	1.00	23	1	8.40	5%	42
			Total	531.11	*Total*	32,414

All US Households spend	2.76	*Billion $/year*	America's household phantom loads consume enough electricity to completely power 3.5 million US households, or the entire country of Greece.
Average US Household spends	27.55	*$/year*	
Average Phantom Load on Grid	4.23	*Giga Watts*	



Chuck's Greatest RE Web Hits

Chuck Heath

Here is a list of renewable energy World Wide Web pages gleaned from my Internet surfing experiences. Additionally, it is available complete with hot links at http://www.homepower.com/chuck.htm.

Please help! We welcome any additions or corrections to this list. The goal is to list every renewable energy page relating to electric vehicles and residential-size power systems, be they hydro, photovoltaic, or wind.

We're still looking for our first hydro home page. Personal web pages relevant to these topics are also most welcome. Please send new additions to our new Email address: sunpwr@telis.org. Thanks!

For room considerations, we have removed the "http://" from in front of the addresses.

Tip: For those using the Netscape web browser, it is usually not necessary to type the "http://" in front of the Web addresses when going to a page, but other browsers may require it.

Associations - Organizations

Alliance to Save Energy	www.ase.org
American Hydrogen Association	www.getnet.com/charity/aha
American Solar Energy Society	www.csn.net/solar/
American Wind Energy Association	www.igc.apc.org./awea/
Aprovecho	www.efn.org/~apro
El Paso Solar Energy Association	www.realtime.net/~gnudd/react/epsea.htm
Energy Federation Incorporated	www.efi.org/biz/efi/
Ground Source Heat Pump Ass.	www.igshpa.okstate.edu/
International Solar Energy Society	ises.org/pages/solarinfo.html
National Fire Protection Association (They write the NEC Code)	www.wpi.edu/Academics/Depts/Fire/Nfpa/nfpa_home.html
Northern CA Solar Energy Ass. (NCSEA)	mars.sonoma.edu/ncsea
Redwood Alliance	www.igc.apc.org./redwood
Renewable Energy Ass. of Central Texas	www.realtime.net/~gnudd/react/react.htm
Rocky Mountain Institute	www.rmi.org
World Energy Efficiency Ass.	www.weea.org

Distributors - Retailers

AAA Solar Supply	www.rt66.com/aaasolar/homepage.htm
Alternative Energy Engineering	www.asis.com/aee
Electron Connection	www.snowcrest.net/econnect
Energy Outfitters	www.energyoutfitters.com
Jade Mountain Inc.	www.indra.com/jade-mtn/
Mr. Solar Home Page	www.netins.net/showcase/solarcatalog/
Natural Energy Systems Inc.	www.gridwise.com/natural/
Real Goods	www.realgoods.com/
Sierra Solar Systems	www.sierrasolar.com/
Solar Alaska	www.mosquitonet.com/~fszip/
Solar Components Corporation	www.solar-components.com
Solar Depot	www.solardepot.com
Solar Electric Inc.	www.solarelectricinc.com
Solar Electric Specialties Co.	www.solarelectric.com/~ses
Solar Evaluation Specialties	www.pathcom.com/~sunone/homepage.html
Solar Panel Power	www.wilder.com/solar.html
Sunelco, Inc.	www.sunelco.com

Electric Utilities - The Grrrid!

The Electric Utility WWW Resource List	sashimi.wwa.com/~merbland/utility/utility.html
Idaho Power Company	www.idahopower.com/txsolsys.html
SMUD Power Resources (Sacramento)	www.smud.org/powres.html
Southern California Edison	www.sce.com/
Utility PhotoVoltaic Group	www.paltech.com/ttc/upvg/INDEX.HTM
Wisconsin Public Service	www.wps.net/solarho.html

Electric Vehicles (EV)

EcoElectric Corporation www.primenet.com/~ecoelec/
The Electric Vehicle Ass. of the Americas www.evaa.org/ev/
Electric Vehicle Sites on the Web northshore.shore.net/~kester/websites.html
Canadian EVs Ltd www.pitzer.edu/~kester/img_cevl.html
NorthEast Solar Energy Association nesea.nrel.gov
Sacramento Electric Vehicle Ass. www.calweb.com/~tonyc/sevahome.html
Solectria Corporation www.solectria.com/
U-Mich Solar Car Team www.engin.umich.edu/solarcar/
Wilde EVolutions www.Wilde-EVolutions.com/
ZAP Electric Bikes www.sonic.net/zap/

Government - Education

California Energy Commission www.energy.ca.gov/energy/homepage.html
Campus Center for Appropriate Technology Humboldt State University sorrel.humboldt.edu/~ccat/
DOE EREN: Solar Energy webdevvh.nrel.gov/RE/solar.html
CMEP Energy and the Environment zebu.uoregon.edu/energy.html
Energy Center of Wisconsin www.ecw.org/
Energy Efficiency & Renewable Energy Network www.eren.doe.gov/

Environmental Org.

Web Directory-Science:Energy www.webdirectory.com/Science/Energy/
Gaining Ground - Sustainable Energy www.nceet.snre.umich.edu/GAIN/GG.W95.html
ISB Photovoltaic Laboratory: zoo4.isburg.ch/lab/pv/pvover.html
National Renewable Energy Laboratory www.nrel.gov/
NIC alt.solar.photovoltaic (newsgroup) sunsite.unc.edu/usenet-i/groups-html/alt.solar.photovoltaic.html
NIC alt.energy.renewable (newsgroup) sunsite.unc.edu/usenet-i/groups-html/alt.energy.renewable.html
North Carolina Solar Center www.ncsc.ncsu.edu/
Photovoltaic Design Assistance Center www.sas.upenn.edu/African_Studies/Org_Institutes/Photovovoltaic_Design_16120.html
Public Citizen's Critical Mass Energy Project www.essential.org/CMEP/home.html
Renewable Energy Technologies www.sandia.gov/Renewable_Energy/renewable.html
Solar Energy International www.crest.org/renewables/sei/
Solar Energy Laboratory www.engr.wisc.edu/centers/sel/sel.html
Solstice: Sustainable Energy and Development solstice.crest.org/
Wind Energy Technology www.sandia.gov/Renewable_Energy/wind_energy/homepage.html
Wisconsin Energy Bureau www.doa.state.wi.us/deir/boe.htm

What's the World Wide Web and how do I get it?

The WWW is the ultimate in electronic democracy. It allows anyone, anywhere to communicate anything to anybody who is willing to look for it. It combines graphics and text in carefully designed "pages" that impart the information desired to the world.

For example, Home Power has our own web pages, and they reside on a computer which is hooked into the Internet full time. This means that someone with Internet access can find our www pages from anywhere in the world just by typing the address http://www.homepower.com into their software which is called a web browser.

The biggest glitch is that you have to purchase a service which lets you use the Internet. You can use big services like Compuserve or America Online, but we recommend that you consider using a local service called an Internet Service Provider (ISP). Almost every community has at least one. Prices can range from $5 per month to $50, depending on the level of service and the amount of competition in your community.

Your ISP will give you software, a password, and a phone number to call with your computer's modem. Once online on the Internet, you need to start your web browser software, type in the web address you want to go to, and then the information shows up on your screen.

You find what you are looking for by finding info like this one, by going to one page and surfing automatic links to other web sites, and by using web search engines (specialized web sites that look for and catalogue millions of other web sites) to type in key words for the info you are looking for.

Most ISPs allow their users to put their own web pages up as part of the service. WWW pages are written in a simple language called HTML, and combined with graphics, a little design sense, and some sort of usable content, your site could be surfed by others.

-Michael Welch

For info on how you can have your own web site, contact michael.welch@homepower.org or call him at 707-822-7884.

Homes: Solar Electric & Solar Thermal

The Building Design Assistance Center www.fsec.ucf.edu/~bdac
Energy Efficient Housing in Canada www.ualberta.ca/~amulder/house/
Energy Federation Inc. www.tiac.net/users/efi/
Enertia Building Systems enertia.com/
Home Power Magazine www.homepower.com
House of Straw: Straw Bale Construction www.eren.doe.gov/EE/strawhouse/house-of-straw.html
Iris Communications: Energy & Environment www.oikos.com/irisinfo
Solar Bright Corporation cybercup.com/solar.htm
Solar Design Associates www.solardesign.com/~sda
Sunergy Renewable Energy www.sentex.net/~sunergy/index.html
Sunlight Homes: Links www.rt66.com/%7esunlight/links.html

Manufacturers-Distributors

American Sun Co, PV Tracking www.acadia.net/sunco/
Ananda Power Technologies www.aptsolar.com/index.html
Ascension Technology www.ascensiontech.com
BP Solar International www.bp.com/other.html
Cruising Equipment www.cruisingequip.com
Eua Nova Energy Wrap Lighting www.cogenex.com
GNB Batteries www.saccom.com/gnb/photov.htm
Inter.Light light-link.com
KISS Laptop solar systems wildwestweb.com/public/KISS_Home_Main.html
Maximum RGB - PV System Design Software www.sover.net:80/~maxrgb/
Midway Labs Inc. Concentrating Trackers www.uic.edu/~slater/midway/
Photon Tech - Mini Solar Panels members.aol.com/photontek/photon/photon.html
SensorMetrics - Environmental Monitoring www.spinners.com/sensormetrics/
Siemens Solar www.rain.org/solarpv/
Solarex Corporation www.solarex.com/
Solar Panel Power www.wilder.com/solar.html
Solarwatt www.solarwatt.com/
Specialty Concepts, Inc. www.wp.com/SCINC/
Sun Selector www.sunselector.com/
Trace Engineering www.traceengineering.com/
World Power Technologies www.webpage.com:80/wpt/

Miscellaneous Web Sites

AEEX Alternative Energy Equipment Exchange www.wetlabs.com/aeex/sintro.html
Friends of the Red Road Homepage hoohana.aloha.net/redroad/
The Gorby Files: Renewable Energy www.halcyon.com/alancrab/re.page.html
The National Energy Foundation www.xmission.com/~nef/
PV Power Resources www.pvpower.com
The REIN Page (RE INFO NET) www-cenerg.cma.fr/rein/
Solar Energy Businesses www.rt66.com/rbahm/business.htm

Search - Lists - Indexes

Alta Vista: Search Engine www.altavista.digital.com/
Lycos, Inc Search Engine lycos.cs.cmu.edu/
W3 List of Search Engines golgi.harvard.edu/meta-index.html
Yahoo Search Engine www.yahoo.com
Fraunhofer Institute - other solar web sites www.ise.fhg.de/Other_Solar.html
Gridwise Power Guide www.gridwise.com
Solar Energy Network Index www.solarenergy.net/tsenindx.html
Solstice Resources: www.crest.org/renewables/sites.html
The Source for Renewable Energy www.rmii.com/theSource/renewableEnergy/
WDRESS (World Directory of RE Suppliers & Services) www.jxj.com/dir/wdress/
WWW Virtual Library: Energy solstice.crest.org/online/virtual-library/VLib-energy.html

Solar Cooking

The Solar Cooking Archive http:www.accessone.com/~sbcn/index.htm
Sun Ovens clever.net/coyote/oven.htm

Wind

Bergey Windpower www.bergey.com/
The Conservation Consortium www.capecod.net/conservation/docs/wind.html
Institute for Wind Energy http://www.ct.tudelft.nl/windenergy/ivwhome.htm
Investigating Wind Energy sln.fi.edu/tfi/units/energy/windguide.html
Manx Wind Energy Services www.enterprise.net/manxwind
Wind Energy Technology www.sandia.gov/Renewable_Energy/wind_energy/homepage.html
World Power Technologies www.webpage.com:80/wpt/

Access

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Fax: 209-878-3557

Solar

Lincoln J. Frost, Sr.

So you are thinking of going solar. You are wondering, "Can I do it? What will it cost?" First question, if you know or can learn what a volt, ampere, ohm, direct current, and alternating current are, if you can add, subtract, multiply, and divide; you've got a start. If you can recognize black, white, green, and red colors, and differentiate between + and -, you've got a good leg up. Having a modicum of skill with hammers, screwdrivers, various pliers, and a few small wrenches, saws, etc. should about do it. Power tools are a big help but you can do it all by hand.

The second question depends on how far you want to go. A good midpoint figure might well be $20,000. A modest setup might be $10,000, whereas a fairly plush one might be $30,000. That's if you do all or most of the work yourself and shop around a bit. My firsthand experience has been with the $20,000 setup, coupled with utility backup and what all it took to get there.

A PV system needs four main things: solar modules, batteries, voltage regulator, and an inverter. There are, of course, miscellaneous fittings and hardware. I selected the Trace SW4024 inverter because it would do just about anything I would want, now and in the foreseeable future, plus I could add on for 240 volts should I want that feature at a later date. Next, I wanted batteries that would have the capacity to keep the installation running for four consecutive cloudy days. I chose twelve L16, 6 Volt, 350 Amp-hr Trojan batteries.

The more or less unknown factor was the solar modules. There are many to choose from. I wanted enough to get started yet to which I could easily add on to fit actual requirements. Ten Siemens PC4JF PV modules were chosen. Finally I found that a Heliotrope PWM CC120E was required for my voltage regulating job. With these four basic components I started to accumulate the "miscellaneous hardware" and build it into the system.

My house had already been built for some years and fortunately had a utility-powered distribution box in a fairly handy place to allow jumping circuits to the new solar distribution box from the old box. Now don't get the idea that I am an electrical whiz or guru, I'm not. I'm just an 84 year old former chemical engineer. The miscellaneous hardware can usually be found at Home Depot, Scotty's, Wal-Mart, K-Mart, True Value, Grainger, Graybar, your local hardware store, or electrical supply house. I live in Everglades City, Florida, pop. 350, 35 miles south of Naples. The four main items you will probably have to get through a dealer. Look in *Home Power* or inquire around locally.

The Installation

Above: Siemens PV modules shown at both summer and winter tilt angles.

A local welder made aluminum frames out of 2 inch angle stock that held five modules each. This was later found to be a poor choice because you can more easily wire six modules in a set, in parallel and in series, than wire the two sets of five in parallel and then in series. #8 wire was used, feeding into 1/0 AWG for the 50 ft. run to the controller. The frames were carefully fitted to the module dimensions so as to be a "kiss fit" all around and were fastened together with small stainless steel bolts, nuts, and washers. They had three hinges along the bottom and three adjustable stays at the top so they can readily be raised and lowered to achieve an optimum angle for the sun, twice a year. Stainless steel bolts have been used wherever possible due to our proximity to the Gulf and salt spray. All the copper wire is oversized since I had a friend who gave it to me. Lucky!

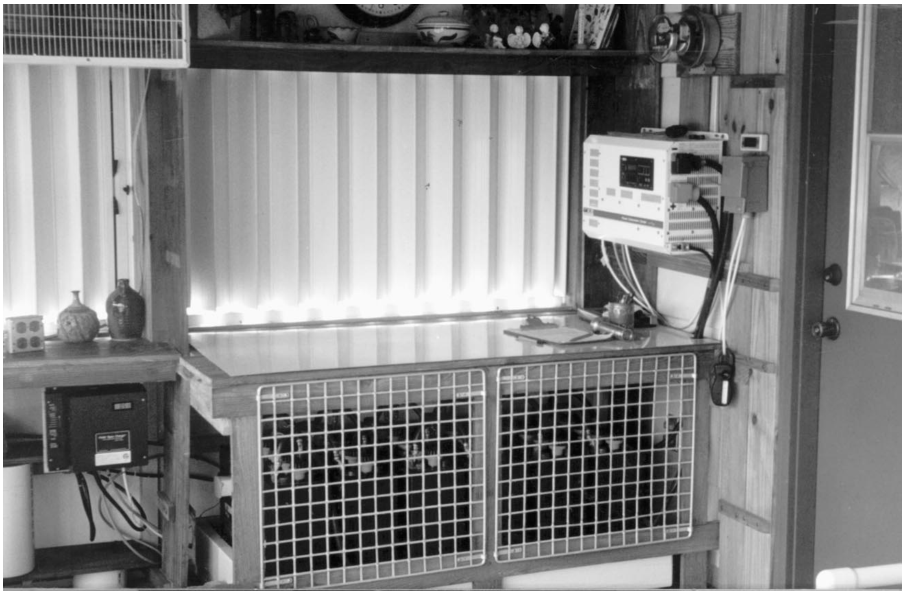
The 12 batteries were wired in parallel and series, four in a set, with 4/0 AWG cable and suitable connectors. 24 VDC comes in on 1/0 AWG cable via the PWM controller to the two opposite end corners and exits to the inverter at the opposite alternate corners of the battery bank via 4/0 AWG cable. Two 50 Amp fuses protect the batteries at the incoming side and two 250 amp fuses protect the batteries to the inverter.

The Trace inverter was hooked up to the batteries and the outgoing 110 vac fed to a Square D 60 amp breaker into the solar distribution box. Since this box was adjacent to the utility box we jumped one house circuit at a time over to the solar box. There are four house circuits on solar and they feed all lighting, the audio-video center, two computers, a printer, copy machine, ham radio shack, one or two Hunter ceiling fans, and two (as I later discovered) refrigerators. We also run an electric tea kettle, toaster, fry pan, roaster, crock pot, bread maker, etc. as occasion warrants.

What will this setup do out in the real world with utility backup? First of all everything worked! We initially needed the utility for back up once a week to bring our batteries up, a 12 hour charge at 20 Amps. That was when we had only ten modules in place. We were delighted that everything worked but now asked, "How well did it work and what could be done to make it work better?" Copious readings were taken of Volts and Amps, coming in at 24 VDC and going out at 110 vac, time of day, condition of sun, what appliances we were using, etc. An analysis of this data showed that everything was working well, but to be more self-sufficient additional solar modules would be needed. We would need to add 14 for a total of 24.

The 14 additional PV modules were ordered. We concluded that they should be in four sets of six to simplify wiring the 12 V modules for 24 V. While shifting the modules around, we availed ourselves of the opportunity for obtaining more data by not shutting the system down completely, but running tests on one of the original sets of five modules while it was still functioning. Then we ran tests on the six new modules when they were ready. Data on the ten modules (original two sets of five) had been obtained previously so we measured 12, then 18, and finally the full 24. While gathering the data we blew the fuse in the original C-30 controller so ordered the PWM 60 Amp Heliotrope. Before it arrived we found we would need the 120 Amp model. Yes, we were taking on electricity in sunny Florida at 67 Amps or more!

With all 24 modules in place and the new 120 Amp controller, we settled down to see just what this setup would do. It was along about here we found that we had been running two regular 20 cubic foot GE refrigerators all along! The solar modules had been set at about 40° degrees elevation (Fall equinox) so now at Spring equinox we set them at about 10˚. These will be our two yearly settings at equinox time, because the sun altitudes here are roughly 43˚ December 21 and 87˚ June 21. Daylight saving time came in and the days got longer. We've been on 100% solar power since January 1, 1996. Keep in mind this is a utility backup system.



Above: Finished Battery enclosure, Trace SW-4024 inverter, Heliotrope CC-120E charge controller.

We do not run any 240 volt on it. No stove, water heater, washer, dryer, air conditioner, nor my shop.

What is the bottom line? Solar is producing 49% of our total electrical requirement! Just about as planned!

Discussion

Let me tell you how we found out that we had two refrigerators on the system. The second and much older fridge stopped freezing caused by a worn out and stuck circulating fan. While the fridge was out of service, we noticed that the PWM controller occasionally indicated "battery charged". This indicated that more watts were being taken in than were being used. What to do with this "excess" electricity? The answer was readily apparent, use it in the second fridge! So after the fan repair job the other fridge was put back in service and thus used up the "excess" electricity.

The next obvious question was just how close were we to a good balance between input and output? We filled the fridge's freezer compartment with gallon jugs of water and let it freeze. Then we put a timer on this fridge and ended up cycling it at 11 AM to 2 PM, the "sunniest" time of the day, and 11 PM to 2 AM when the least electricity was being consumed. The water in the jugs acted as an energy reservoir, freezing and thawing as the fridge was cycled. The PWM does not now show "charged" and we still do not need utility back-up except to offset sudden energy demands and then only for the time of the relatively short requirement!

When using the Cannon PC310 copier, we found that, occasionally when the battery voltage is a little on the low side, the copier will "stick". This can probably be corrected by setting the Trace's Min. Bat . Voltage 0.50 volts higher.

When using the TenTec Delta II short wave radio I thought that there was some RF interference between receive & transmit. Changing the ham radio to a Yaesu FT676GX seems to have eliminated this problem. Further investigation will better pinpoint the cause of this radio frequency interference (RFI) problem.

The Bottom Line

It would be of interest to compare this year's performance to last year's, using past electric bills (before solar) as the best reference available. Taking the 34 month average (January '93 to October '95) as 35.6 kWh and the 8 month average (November '95 to June '96) as 18.1 kWh, it is found that the present system is providing about 50% of our total electric requirements and about 100% of our engineered goal.

Below: Twelve Trojan l-16 Batteries, 1050 Ampere-hours at 24 Volt.

Above: Solar modules, juncture boxes,
and adjustable stays.

PV Modules
The Siemens PC4JF photovoltaic modules were readily installed and mounted in the custom made, hinged, aluminum frames. Wiring was made a little easier by using auxiliary connectors to attach the #8 wire to the terminal boxes. They were wired in sets of three in parallel then the two sets per frame are paralleled for 24 Volts. The owner's manual and installation guide were somewhat helpful and should be read and reread to insure a correct installation.

Battery Charge Controller
The Heliotrope General CC120E controller was easily installed after very carefully reading the manual. It came equipped with a fan and battery temperature sensor. The table and diagram in the manual about state of charge required some study. Several trial settings were needed to zero in on the correct setting that ended up being 30.6 volts. The door, or the front plate, of this controller should be hinged so that the adjustments can be more readily accessed.

Batteries
The twelve Trojan L16 batteries were checked on receipt for voltage and were found to read 6.27 Volts in February '95. After being in the system during it's many trials and adjustments the specific gravity read 1.280 on March 29, '96 just after an equalization charge. A second complete check was made and the specific gravity was 1.200 on all cells.

Frost System Costs

Quan	*Material*	*Cost*
24	Siemens PC4JF Modules	$9,250
1	Trace SW4024 inverter	$2,500
12	L16 Trojan Batteries	$1,690
	Misc. Supplies & Labor	$1,642
4	Aluminum Module Frames & Stays	$1,000
1	CC120E Heliotrope Controller	$451
	Conduit & Fittings	$400
	Material & Labor for Battery Enclosure	$250
	Material & Labor for Battery Tray	$250
	Battery Box Materials	$200
36	A8L6D Hydrocaps	$192
24	Copper Color-Keyed Lugs	$125
1	Digital Voltmeter	$80
200 ft	#8 wire	$75
1	Battery Disconnect	$56
6	Siemens Breakers	$50
12	Split Bolts	$48
36	5/16" Stainless Bolts, Nuts & Washers	$36
2	Ground Rods	$20
30 ft	4/0 AWG Cable	N.C.
150 ft	1/0 AWG Cable	N.C.
2	250 Amp Fuses	N.C.
2	50 Amp Fuses	N.C.
	Total	$18,315

Inverter
The well-made Trace SW 4024 is the most complex of all the components. The owner's manual has been written for the expert and those already knowledgeable in the subject. It would be more readily comprehensible if it were written by an amateur with little or no knowledge of the subject. After many and continuing trials it has been set for this particular installation.

Comments
It has now been 1 1/2 years since the start of this project. The first six months were devoted mostly to acquiring the equipment. The second six months were devoted to assembly. The third six months has been spent fine-tuning it, analyzing all the information, and coming up with actual data.

Access
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PV SYSTEM UPGRADE

Wm. von Brethorst

In early 1993, Bob & Hope Stevens had just purchased a large tract of former mining land west of Helena, Montana. The site was about $20,000 from having power lines and four miles from the nearest main road.

The Design

The house was designed with the help of Steve Logan with Recycled Resource in Missoula, Montana. The theme was one of sustainable technology coupled with a high content of recycled building materials. Work began in the spring of 1993 with the delivery of a Winco PSS-8000 propane generator for construction power.

Bob & Hope were readily open to the idea of energy saving devices such as radiant hot water floor heating, low energy refrigerators, and compact fluorescent lighting. Coupling these with a gravity fed water system seemed a match made in sustainable heaven.

The electrical, heating, and water systems were designed to be as energy efficient as possible while providing high reliability and comfort. The site afforded only marginal solar access so a structure using telephone poles and steel bracing was constructed to lift the original 16 Solarex 64 Watt modules in racks of 4 to a height allowing much greater solar exposure. An additional nine used Solarex S-10 modules were added in the spring of 1996.

The design process was the most important, during which all of the heating and electrical systems were selected. A computer model was made using the electrical load characteristics of the appliances and equipment selected such as the boiler, pump, lighting, and kitchen appliances.

The System

The load scenario of this home dictated a much lower wattage requirement since the generator would automatically operate to pump water up the 100 foot hill behind the home to a 2000 gallon storage tank. The battery bank, being the most important item of the system, was designed to provide the entire home load for 4.5 days or 6 days of reduced load in case of bad weather or generator problems.

A 24 VDC system was selected for efficiency, though some 12 VDC loads were tapped off the battery bank. IBE industrial 2 VDC cells in steel cases were selected. The bank was sized at 1292 Amp hours (12 cells at 1292 Ah at a 20 hour rate). This gave ample power for surge loads such as pumps while providing longevity during periods of low solar potential.

The batteries were housed in an enclosure built for easy access, venting, and visibility. Using individual 2 VDC cells meant only 12 cells to check for water level and specific gravity when required.

We like small propane generators as backup power for a properly sized PV-hybrid system. They can provide years of service with little maintenance and can be serviced by any small engine repair shop.

The original Trace 2624 inverters and other major system components were installed in July of 1993. The inverters were connected to supply 120 vac power each to half the power panel. The house wiring was laid out so that certain circuits were priority and others were secondary.

Above: Owners Hope and Bob view the system monitor during final construction phase.

Below: Two new Trace SW 4024 inverters installed with the revised system layout.

The inverters were then set-up so that only one would remain on at night, while the other's search mode was set to require a large load, at least two compact fluorescent lights, to turn it on.

Battery charging was accomplished by two Todd Power Source solid state chargers each rated 75 amps at 12 VDC. Wired in series, they produce 28.8 VDC. To avoid overloading the generator with pumping and battery charging, a control and time delay scheme was devised to operate the pump with a float switch in the main storage tank. This triggers a light and relay, which operates after a delay for engine warm-up. A battery voltage monitor and logic circuit was used to allow charging, if required, after the water demand had been satisfied. Afterwards, the generator shuts down.

The New System

All of these systems worked flawlessly for the past three years until they were replaced this spring by controls in the new Trace SW-4024 inverters. The bulk of the controls and systems remained the same except that many of the old analog controls were changed to operate from logic relays onboard the new inverters.

When the new Trace inverters were installed they almost instantly transformed the electrical efficiency of the entire system. Having up to 8000 watts and 240 vac power in the house brought about an entirely new lifestyle. With the addition of new solar panels, dependency on the generator was almost gone. No longer did the boiler pump hum, no longer did the vacuum cleaner and washer groan under a heavy load.

Stevens Energy Consumption

#	Appliance	Run Watts	Hours/ Day	Days/ Week	W-hrs/ Day
1	Well Pump	800	2.0	5	1143
1	Refrigerator	120	7.0	7	840
1	Freezer	120	5.0	7	600
1	Domest. Hot Pump	175	2.0	7	350
4	Liv. Rm Lights	23	3.0	7	276
1	Hydronic Pump	120	2.0	7	240
3	Kitchen Lights	23	3.0	7	207
1	Boiler Power	60	3.0	7	180
2	Accent Lights	35	2.0	7	140
2	Bdrm Lights	23	3.0	7	138
1	Washer	800	0.6	2	137
8	Dining-Lights	10	2.0	6	137
1	Stairway Light	23	5.0	7	115
1	Dryer (Propane)	455	0.8	2	104
2	Outside Lights	23	2.0	7	92
2	Bathrm Lights	23	2.0	7	92
1	Microwave Oven	900	0.1	6	77
1	Garbage Disposal	600	0.1	7	60
1	Dishwasher	350	0.5	2	50
1	Shop Tool	350	1.0	1	50
1	Propane Oven	500	0.3	2	43
1	Hall Light	23	1.0	6	20
1	Garage Light	23	0.5	4	7
2	Exhaust Fans	1	2.0	7	3
	Energy Consumption in Watt-hrs per Day				5100

In summer the Stevens are almost completely energy independent. The only hitch was that, from the beginning, the well pump was oversized. A 1 1/2 hp well pump that can deliver 20 gpm was not necessary for this type of stored/gravity-fed water system. In June of 1996 this pump was replaced with a Grundfos Sub-Pump, one of the newest models with a soft-start feature which removed the large starting surge of the larger well pump. A 3/4 hp pump producing 7 gpm is all that is needed from a well that only produces 9 gpm.

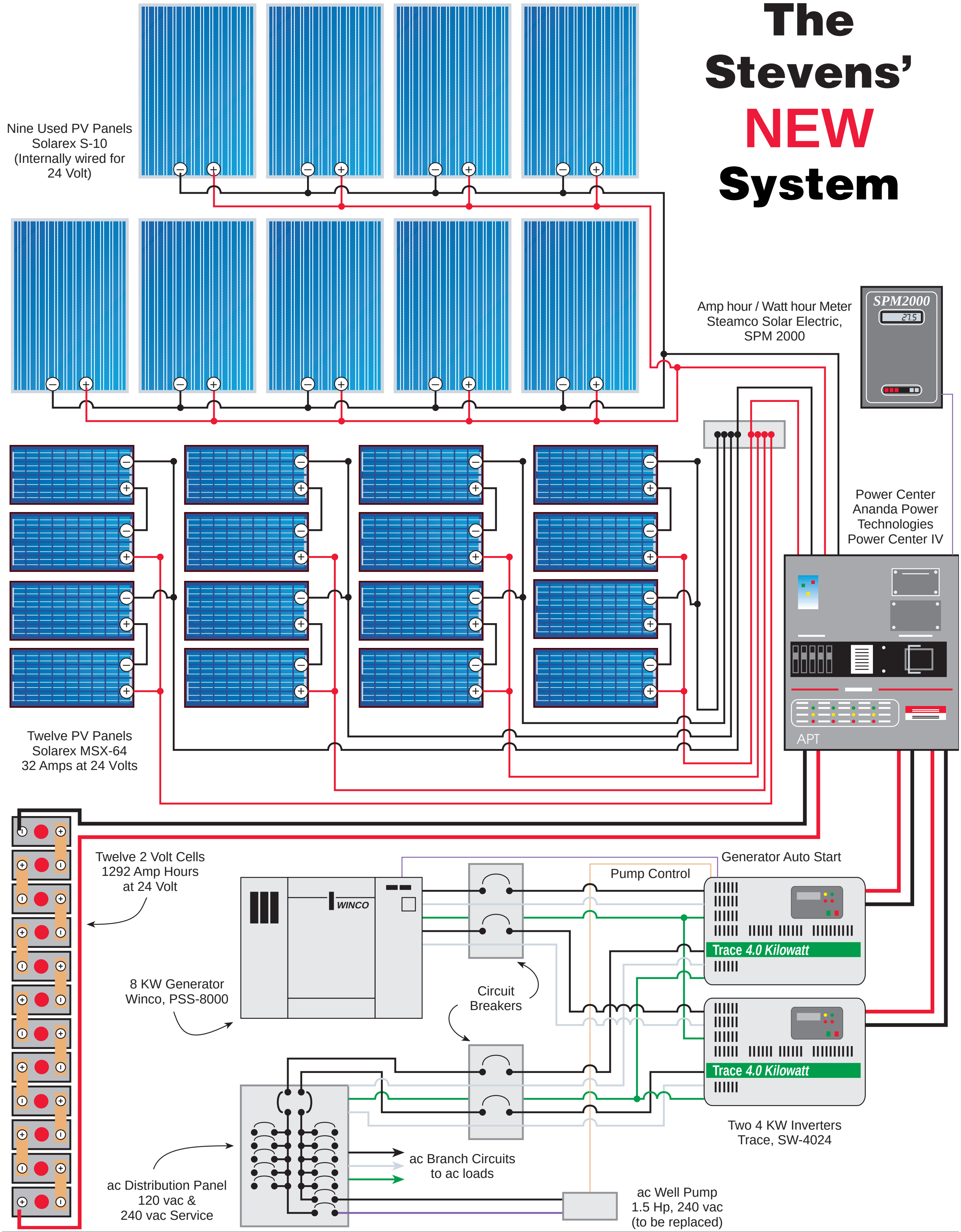
Everybody Gains

As technological advances continue, every alternative energy system will change and any system can be brought up to the latest standards for a modest amount of investment. The returns can be staggering. Today's state-of-the-art solar home is virtually no different from a standard home in feel or design. However, these homes can use ten times less energy each day. This savings is passed on to the homeowner, but in a larger sense, is passed on to all of us. As energy demands grow, those who use less will profit first and the rest of us can benefit from their frugality in many ways. An off-grid home is far from being just some cabin in the mountains, but can look like any home down the block.

This is a typical off-grid home designed and executed with the help of enlightened homeowners and forward-looking architects/designers. When the correct components come together, almost anything is possible. The cost of such a properly designed and executed system is about 5 to 10% more than doing the same old thing. If the human species is to survive long term on this planet, doing the same old thing must cease.

Below: Bill von Brethorst, the author and installer, behind the new PV array.

The Stevens' NEW System



Stevens System Costs

Original System

Quan	Material	Cost
16	Solarex 64 Watt Modules	$6,240
12	IBE Industrial 2 Volt Batteries	$4,932
1	Winco PS8000 Propane Generator	$3,985
2	Trace 2624 Inverters	$2,976
	Cable, Hardware, Miscellaneous	$2,200
	Installation	$2,000
1	PV Structure	$450
	Controls	$350
	Original System Total	$23,133
	System Upgrade	
2	Trace SW4024 Inverters	$5,970
9	Solarex S-10 Used Modules	$3,200
	Installation	$600
	PV Structure	$300
	Cable, Hardware, Miscellaneous	$250
	Trade in on Old Inverters	($800)
	System Upgrade Total	$9,520
	Entire System Total	$32,653

If every home were as energy conscious there might be no energy crisis and we would not need any nuclear power plants. We could free the rivers and stop burning atmosphere-polluting coal with the energy savings from this simple step. It may not happen right away, but more people are beginning to discover the joy in living simply and purposefully. Ironically, all of these advances making it possible are a result of the Computer age.

Right: Solar Copper Cricket heating storage tank.

Access

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• Web: http://www.pacificrim.net/~bydesign/ps.html

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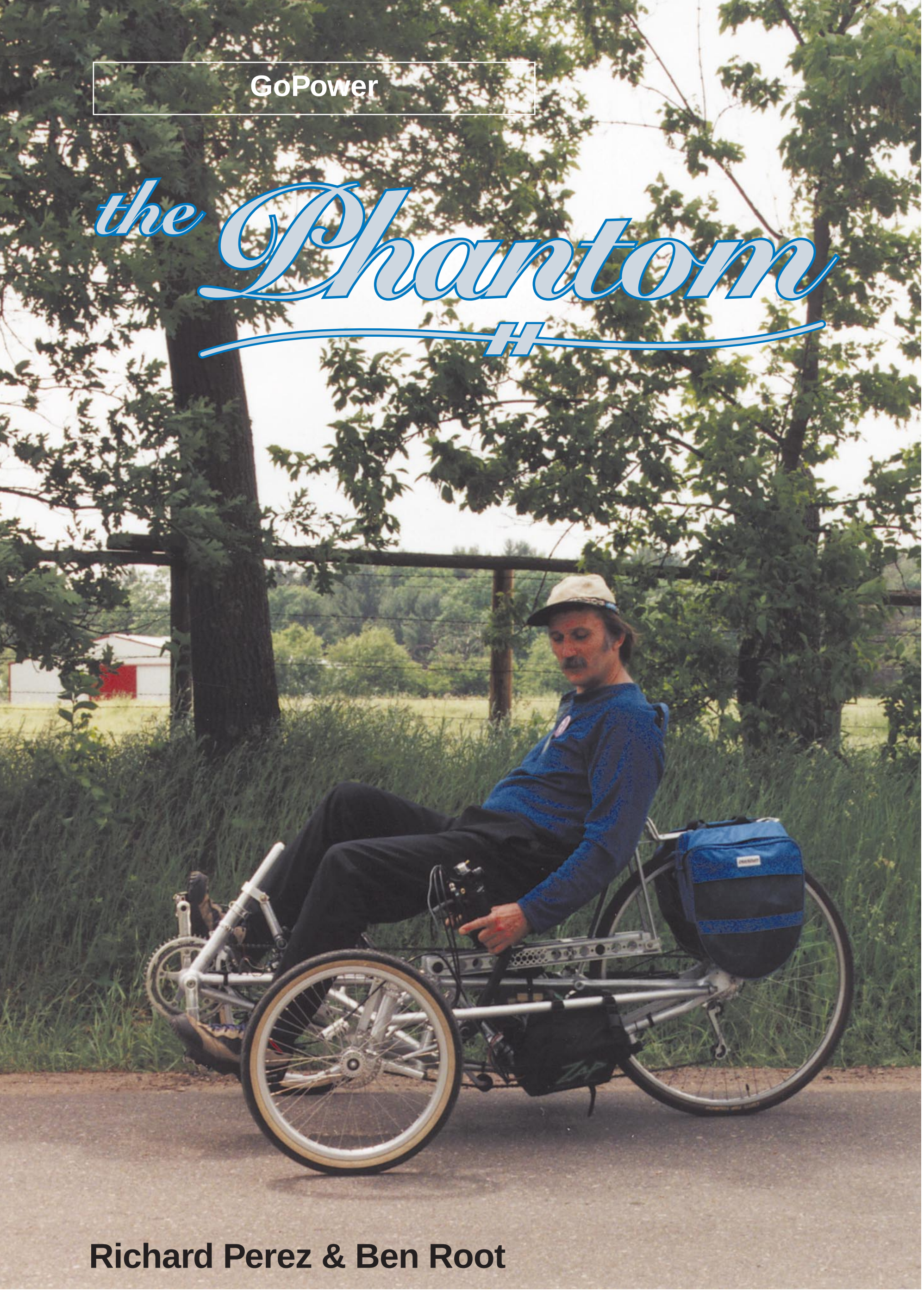


the Phantom

Richard Perez & Ben Root

One of the best things about attending the Midwest Renewable Energy Fair is meeting new people and seeing their inventions. Robert Turner, and his new human / electric-powered trike, Phantom, are a perfect example. When I first saw the Phantom, I thought it was a new production machine that had escaped my attention. Wrong! The Phantom is a homebrew labor of love.

The Phantom Concept

Robert wanted to make a commuter/touring trike that was fast, stable, and could be powered electrically with a small motor and battery. It would be light—only 102 pounds complete with motor and battery. It would be capable of high speeds—about 40 mph with the human pedaling hard and the motor working at high speed. It would be safe and stable with three wheels and a low center of gravity. And it would be comfortable with a recumbent riding position and well executed human to machine interface. Robert succeeded—his vehicle is all of the above, in addition to being an engineering and fabrication work of art.

Craftsmanship

I'm not much of a pedal-powered person. The last serious cycling I did was at age 15 on an English-made Philips with a three speed Strumley Archer gearbox. Don't laugh it was a hot machine in 1960 and I used to outrun Schwinns all the time. I'll let a serious cyclist, Ben Root, tell you about how the Phantom pedals. What struck me about the Phantom was the craftsmanship. I've done some welding in my time, and I've known some great welders, but I have never seen such perfection and detailed finishing as I saw in Robert Turner's Phantom. Each joint in the TIG welded aluminum frame was perfect. In fact, the joints didn't look welded, they appear to have been organically grown in place.

Once I got past the perfect welding I began noticing the engineering and use of modern hi-tech bicycle components. For example, the Phantom has two hydraulic disk brakes, one on each front wheel (a disk is also available for the rear wheel). I remember that one of the reasons my old Philips ran away from Schwinns was that I could approach curves faster because I had two brakes, not the single rear

Above: Everybody is immediately taken with the clean organic craftsmanship of the welded aluminum chassis.

brake found on most US bikes at the time. With two hydraulic disc brakes, the Phantom should be able to stop quickly and safely in any situation. While the steering looked uncomfortable, once I sat in the seat and lowered my hands, there was the steering—located in the perfect position.

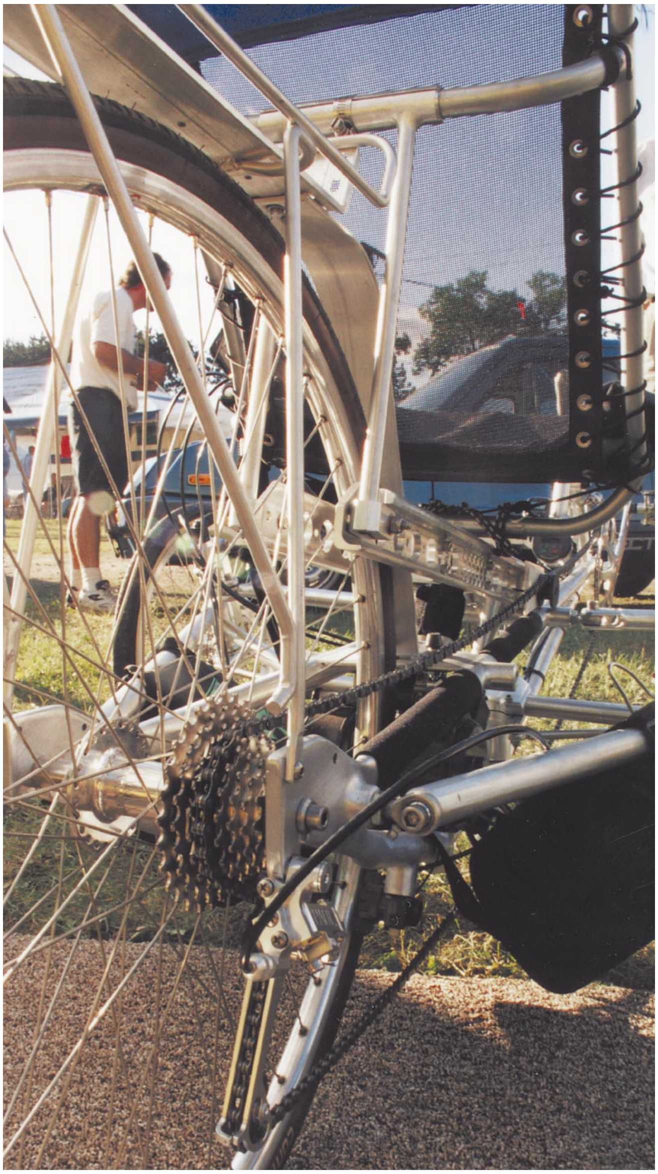
Riding the Phantom—Ben Root

Piloting the Phantom was an inspirational experience. Unfortunately there were still bugs in the power transfer system when I rode the trike so I was limited to using the pedals for propulsion. But the feel of being in the driver's seat was a true rush, and the idea of eventually being able to cruise at the rated speed of 18 mph for a full hour on a charge without pedaling (longer and faster with pedal assist) was the real attraction. At just over 100 lbs. the Phantom is a bit heavy for a bike, but light enough to make an efficient EV. When I rode the trike,

Above: Detail of the right front wheel shows the hydraulic disc brake and rearview mirror.

Below: The human power interface and data feedback system (i.e. pedals and gauges).

Right: A View from the rear shows the drivetrain and the Zap battery packs (in black bags) on either side.



Phantom Specifications

Design	Folding
Model Designed for	All Weather Touring and Commuting
Steering Type	Under Seat - Four Way Adjustable
Wheelbase	38 inches
Track	46 inches
Overall Length	72 inches
Overall Width	48 inches
Overall Height	41 inches
Weight	102 pounds
Seat Adjustment	6 inches
Seat Height	21 inches Fox Air Shock Suspended
Recline Angle	50˚ to 80˚ Adjustable
Seat Frame	Aluminum
Seat Material	Nylon Mesh and Foam
Range	30 miles electric
Top Speed	40 mph with fabric body
Speed-Motor only	Low 10 mph -7 Amps Medium 15 mph -30 Amps High 18 mph -45 Amps
Electric Motor	Bosch 1.2 HP at 12 VDC
Battery	Gates Genesis Gel Cell 26 Amp-hrs at 12 VDC
Frame Construction	Aluminum TIG Welded
Ball Joints	Heim HMX Series
Fittings	Stainless
Head Tube Angle	70˚
Front Derailleur	Campagnolo
Rear Derailleur	Paul
Freewheel	Sach
Shifters	Grip Shift X-ray
Bottom Bracket	Phil Wood
Crankset	Campagnolo 42 and 52 Teeth
Freewheel Range	12 to 28 Teeth
Front Brakes	Amp Disks, Cable Actuated Hydraulic
Rear Brake	Magura Hydraulic
Front Wheel- Hub	Phil Wood Quick Release
Front Wheel - Rim	Sun 20 inch Rhyno Lite
Front Wheel - Spokes	36 Wheelsmith Stainless
Rear Wheel - Hub	Phil Wood Tandem/Brake
Rear Wheel - Rim	Sun
Rear Wheel - Spokes	48 Wheelsmith Stainless
Projected Price	$6,600

Options

Rear Disk Brake	Amp
Power Meter	E-Meter
Fabric Body	Graphite Rod and Nylon Fabric
Fairing	Z Zip
Bolt-On Front Hubs	Phil Wood
Front Rim 24 inch	Sun
Front Rim 20 inch	Sun
Rack and Panniers	Blackburn
Lighting	Vista Lite
Rear Safety Flashers	Vista Lite

Note: Phantom specifications are current at the time of publication, but Robert is continually working on and improving the Phantom, so these specifications are bound to change.

without the electric assist, the unit needed a third "granny" gear up front to make accelerating from a stop quicker, and safer. I understand that addition has since been made. Once up to speed the trike felt great. It was solid and stable with a Fox air shock suspension under the seat to suck up road vibration and pot holes. The steering felt a bit squirrely at first but within minutes I decided that "responsiveness" was a better description and I wouldn't have it any other way. The steering reacts immediately from very subtle input, more like a bike or motorcycle, less like a car. This touchiness made me want to test the stability of the machine in a rapid hard-turn situation. I found a suitable parking lot and proceeded to play the kinds of games that one used to play with mom's station wagon on Saturday nights. I cranked into turns harder and harder, trying to feel the point where the inside front wheel would start to

lift. No deal! The front wheels were actually starting to squeal but there was never evidence that the trike was close to tipping. This, combined with the fact that the trike tracks straight enough to ride no-hands on the straight-a-ways makes me now love the steering.

The Phantom is loaded with high end componentry. Robert's attention to detail shows through everywhere, from the American made Paul brand rear derailleur to the custom E-Meter mount. If this unit meets its electric propulsion specifications and is set up to hold a couple of bags of groceries or a kid's seat it could replace a huge percentage of around town automobile use.

In America's Workshops

I sometimes forget that the Wright Brothers made the first airplane in their bike shop. America's workshops are the breeding ground of next generation engineering and superlative craftsmanship. When I compare the function and quality of most of the mass-produced junk offered to us, the Phantom appears to have been made on another planet by advanced aliens. Detroit could really learn a thing or two from Robert Turner….

Right now, Robert is recovering from the thousands of hours it took to build the Phantom by riding some of the 2,000 miles of back roads in his county. He has been riding about 100 miles per weekend. When I last spoke to him, he sparkled with the successful runs of the first Phantom hybrid electric prototype. I can only hope that Phantom finds its way onto the feet of pedaling commuters everywhere.

Access

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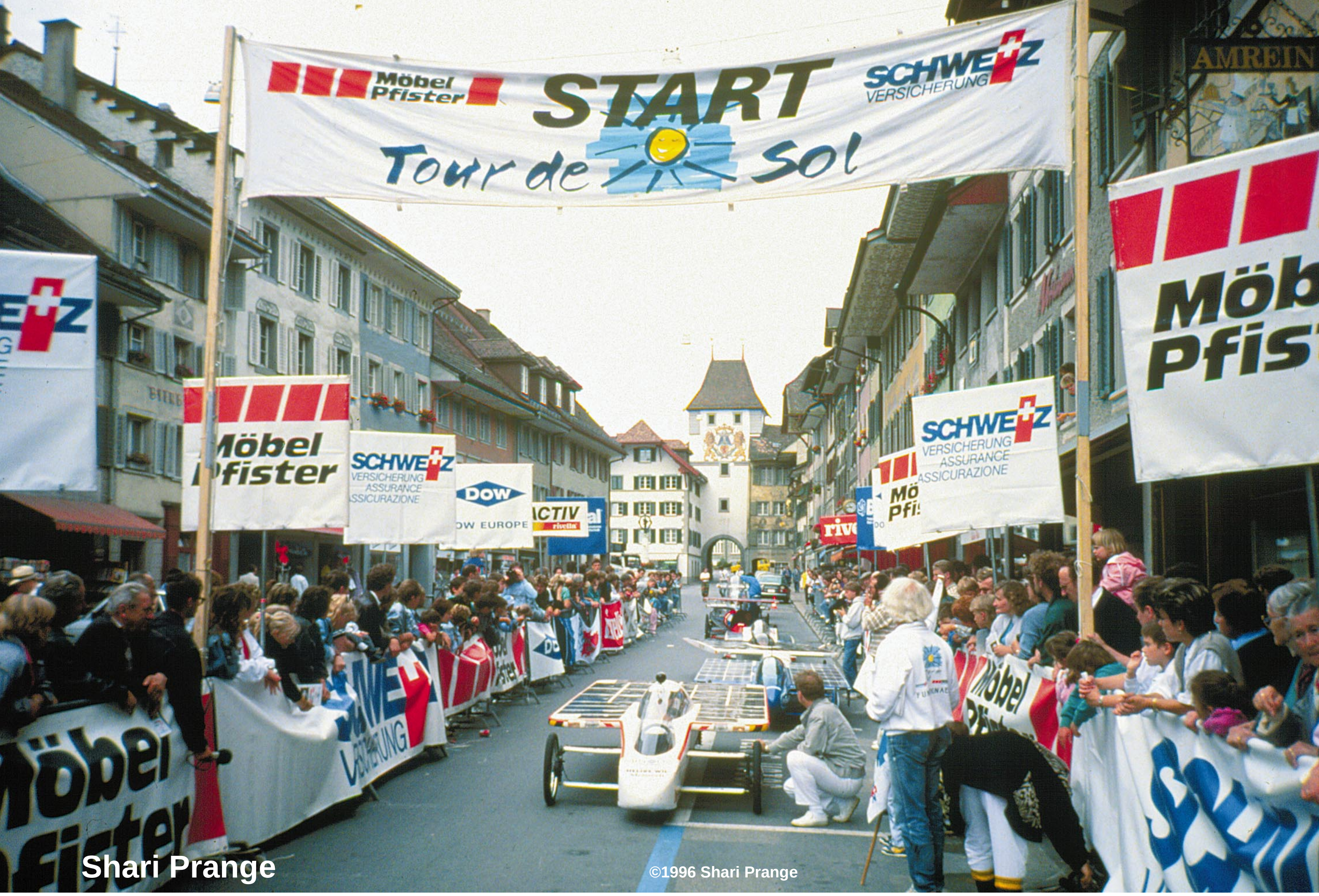


Shari Prange

©1996 Shari Prange

Above: Both the Swiss (pictured) and American Tour de Sol races are multi-day cross country events. Slide courtesy of the Northeast Sustainable Energy Association.

Let's Go RACING

Say "electric race car" to a dozen people, and each of them will get an instant mental picture of a car. However, there may be a dozen different pictures. Some may look like Indianapolis 500 cars, exotic and low. Others may look like street cars with numbers on the doors and lots of sponsor decals. Still others may be flimsy solar-powered teardrops.

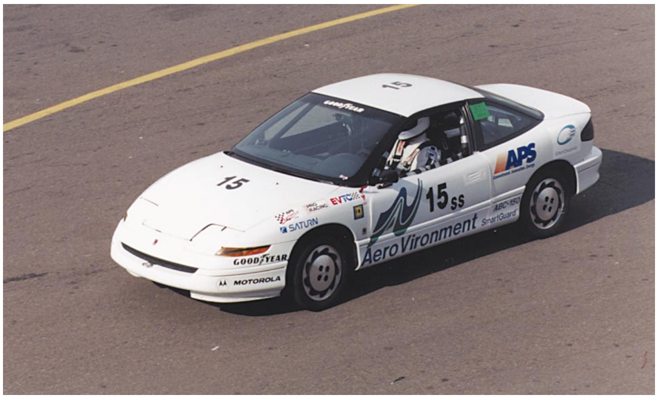
In recent years, electrics have moved into the racing world in a big way. Many fans—like me—came to EV racing with little or no knowledge of traditional racing and terminology. "Racing" encompasses a blurred hodge-podge of dissimilar cars and events in our minds. When we learn more about it, we start to see the distinctions. You wouldn't race a stock car against an Indy car, any more than you would race a Quarterhorse against a Thoroughbred. Let's take some time to separate the different elements, and get them in focus.

Type of Car

One distinction is the type of car. There are dozens of classes of racing. However, all of them can be grouped into some broad categories.

Stock Cars
Stock cars look like street cars, but they vary widely under the skin. In some events, the car is “box stock” original, just like it came from the factory. In conventional racing, this would include some cars in Sports Car Club of America (SCCA) events such as autocrosses.

The autocross is a test of handling done on a short twisty course defined by pylons set up in a parking lot. This is the one type of racing that is open to almost anyone. The only special equipment required is a helmet, and there is no special racing license required.



Above: A stock car looks just like a street car on the surface, except for all the decals.

In EV racing, this kind of pure street car would compete in events like club rallies, which are run on public streets in traffic, observing all traffic laws.

Other stock cars have been modified for racing with special power trains, roll cages, doors pinned or welded shut, and safety harnesses and nets. In conventional racing, these are found on race tracks at SCCA and National Association of Stock Car Racers (NASCAR) events. In electric racing, they will be found on tracks at events like the Phoenix APS Electrics.

Above: Purpose-built race cars cannot be driven on public streets–physically or legally.

Above: A Formula Lightning is an example of a semi-spec open-wheel race car. They are raced primarily by universities.

On the extreme end of the scale are cars that are “stock” only in a dark alley. These are “silhouette” cars. The body must match the silhouette of a stock street car by matching a cut-out template placed over it, nose-to-tail. However, the body panels can be made of a lighter material, and under the skin, almost anything goes. The car doesn’t even have to drive from the same end as a stock version.

These cars are found in NASCAR. The closest comparison in electric racing would be cars with stock-looking fiberglass hoods, fenders, and door panels in races like the Phoenix race.

Above: The ESR-1 is a prototype of a closed-wheel race car.

Purpose-Built
The other main car type is the purpose-built race car. This is a specially designed racing vehicle that is not licensed for public streets. In most cases, these cars couldn’t drive on the streets if they wanted to, because they are so low a reflector on the pavement would tear up the car. The skin is fiberglass or carbon fiber. The best known of these cars are the Indy cars.

Above: Big oval tracks like Phoenix International Raceway are designed for high speeds.

Everything on these cars is designed to very precise tolerances. A fraction of an inch constitutes a major alteration, and the cockpit fits the driver like a glove. The cars look flimsy, and seem to fly apart easily at any impact. However, they have been designed to protect the driver as much as possible, with surrounding framework, harnesses, and fuel containment.

A low-end purpose-built SCCA car may cost less than $30,000. On the other extreme, a Formula I car will cost ten to a hundred times that much, and when you include the necessary spare parts for a normal season of racing the price easily tops $1 million per car.

In electric racing, this group is primarily composed of the Formula Lightning cars.

Open Vs. Closed Wheel

There is a fine distinction among purpose-built racers that many newcomers don't recognize: open-wheel vs. closed-wheel. The open wheel cars have no enclosure at all around the wheels. Indy and Formula I cars are of this type. Closed-wheel cars have fenders, although much closer and more aerodynamic than those on street cars.

Above: Solar cars competed in the early Phoenix races, but mostly participate in cross country enduros such as the Australian Challenge.

Open-and closed-wheel cars generally do not race together. All else being equal, open-wheel cars need more power, because the uncovered wheels create aerodynamic drag. They are also more dangerous in an accident. If two open-wheel cars touch wheels at speed, one of them will go spectacularly airborne.

Electric open-wheel cars, such as the Formula Lightnings, are much heavier than their conventionally fueled counterparts, and they race at much slower speeds. So far, we don't really know what would happen in wheel-to-wheel contact between electrics, but someday we're sure to find out.

In conventional racing, closed-wheel cars are found in the International Motor Sports Association (IMSA) and SCCA events. In EV racing, there is not at this time an event for closed-wheel cars. There are discussions about such a class for future Phoenix races.

Above: The twists and turns of a road course impose different stresses on car and driver from those of an oval track.

The "E" Sports Racer is a closed-wheel electric car that has been pioneering the concept of EVs racing side-by-side with conventional cars in the San Francisco Region of the SCCA. In the 1995, it was given its own class for both Solo II (autocross) and Solo I (on-track time trials) events. The national SCCA is interested in developing a class for electric racers like this.

Formula & Spec

Purpose-built race cars are sometimes called formula cars. That is, the design must fit within specified parameters, which define the formula. These will include dimensions, weight, shape, horsepower limits, etc. Anyone can build a car for this kind of class, as long as all the parts fit within the formula.

A spec car is more strictly defined. In a pure spec car, the whole car is specified. All parts must come from the authorized manufacturers, period. There may be a few settings or adjustments that are open to the racing

team, but that's all. In conventional racing, this would include the International Race of Champions (IROC) cars.

The point of the spec car is a field of evenly matched cars. No one can "buy" the race with fancy expensive components. The competition is very close, and winning depends on the skill of the driver.

Some classes are semi-spec. For example, the University Spec Class at the APS Electrics requires a Formula Lightning chassis. However, the teams are free to choose their own drive system and batteries.

Open Class

Many EV events have included an "open" class, also known as "run what ya brung". This class swept up all the odds and ends (some odder than others) that wanted to participate but didn't fit into the requirements for more conventional classes. This trend seems to be fading. One reason is that there are now enough cars that do fit normal classes to stage a reasonable event.

Another reason is safety. As speeds increase, safety becomes more critical. Because the open class has so few rules, it is harder to control safety in design and construction. It also means that the cars may be poorly matched in performance, with some much slower than others.

Course Type: Street Vs. Track

Another distinction among different types of racing is the type of course used. The major distinction is between street courses and tracks. A street course is laid out on existing public roads. In a rally, the competitors must mix with normal traffic, and obey all normal traffic laws. In speed events such as the Long Beach Grand Prix, the course is closed to normal traffic for the duration of the race, and traffic laws do not apply. Street courses that are regularly used for major events, such as those in Monaco, are kept smoothly paved and groomed, since a pothole or lumpy patch would be disastrous.

Most racing, however, is done on tracks. In conventional racing, these may be paved or dirt (or sometimes mud). For electric cars, pavement is essential.

Oval Vs. Road

The tracks can be further categorized as oval or road, and there is endless debate among racers and fans as to which is "best". The Indianapolis 500 is run on a two-and-a-half mile oval. The early Solar & Electric 500 in Phoenix ran on a one mile oval. Ovals may be as short as one-quarter mile. Oval tracks, especially the long speedways and superspeedways, allow much higher speeds than road courses.

Above: Anyone can compete in an autocross, a twisty course set up in a parking lot for a one-time event.

A road course, such as Firebird Raceway in Phoenix where the APS Electrics is now held, simulates a country road, with sweeping curves, S's, and hairpins. Some tracks, such as Sears Point Raceway, also include substantial hills. All these turns and hills lower speeds. However, road course fans feel this kind of track demands more skill than a flat or banked oval, where the driver "only has to know how to turn left".

The two kinds of tracks require differently set-up cars, also. On an oval course, the stresses on the two sides of the car are different, and the outside tires will wear much faster. Suspensions are altered and weight is "jacked" to the inside to improve the car's handling. In some classes, the car has visible "stagger", meaning that one side sits higher than the other, and often uses a larger size of tire.

A car on a road course must be able to handle g-forces in both directions, so it is more evenly balanced side-to-side.

The Strip

A third kind of track is the strip. This is a pure acceleration or speed event. These cars are set-up to go in a perfectly straight line, as fast as possible. The well-known quarter-mile drag event is a test of acceleration, whereas a salt flat car, or "streamliner", races for a record top speed over a set distance.

The Hill

The final kind of course is a hill climb. Traditionally, this has not been considered an EV event, since climbing hills at speed is so strenuous on batteries, motors, and controllers. However, in recent years there have been EV entries in the annual Pike's Peak Hill Climb, with respectable results.

Race Format

A third area of distinction among types of races is the format of the competition. This breaks down into three

major categories: duration, field size, and winning criteria.

Short, Medium, Or Long?
The shortest kind of race is the time trial. Each contestant is racing primarily against the clock. Cars are released onto the track at intervals, and there is no passing or fighting for position. In a drag event, each "race" can be measured in seconds. If you blink, you've missed it. In SCCA Solo I and Solo II events, each car is allowed two to four laps, and only the best lap will count. In this kind of event, each driver concentrates on his or her car and the track, trying to turn in a personal best performance.

The next longer race would be a sprint. This may last a few minutes or as much as an hour. Most are in the twenty to forty minute range. In this type of race, there is generally no refueling. The races are so short that a pit stop would cost more time than could be recovered in the remaining laps. Drivers battle for position throughout the race. SCCA races fall into this category. While the early Phoenix races featured enduros, they are now emphasizing shorter sprint races.

Long races requiring refueling are enduros. In conventional racing, this would include the Indianapolis 500 and LeMans. In EV racing, it includes some longer track events in which quick charges or battery swaps are permitted. In these races, drivers pace themselves and their fuel consumption. They may choose to hold a mid-pack position for much of the race and only begin to battle seriously in the closing miles.

The longest races are the multi-day events such as the American Tour de Sol and the Australian Challenge. On cross-country events, racers often can't even see many of their competitors. Relative positions change over the course of hours, rather than minute-by-minute.

Field Size
How many cars are on the course? On the low extreme, a streamliner races alone against the clock and past records. In a drag race, two cars may compete simultaneously on side-by-side lanes. In a Solo I or Solo II event, numerous cars may share the track at the same time, but they are released onto the track at metered intervals. They are competing against the clock, and only indirectly against each other. This kind of spacing is also common in traditional EV rallies.

The racing most of us are familiar with is wheel-to-wheel racing. All the cars start together, they pass and battle for position, and the first one over the finish line is the winner. Sometimes two or more classes share the track at the same time. In this type of racing, it is fairly easy to tell who is leading. You don't need to wait to see the times on the score sheets at the end. Action is heated and competitive.

Winning Criteria
The final area of distinction is the type of criterion used to determine a winner. Many of us automatically think, "Well, of course it's the car that finishes first," but this isn't necessarily true. That is a winning criterion based solely on speed. It is what we are familiar with from drag races and the Indianapolis 500, where the race runs for a set distance, and the first car to cover the distance wins.

Most EV events, however, are based on a distance criterion. This is true at traditional rallies. The event runs for a set amount of time, and the car that covers the most distance in that time wins.

It would seem, at first glance, that this would still be the fastest car, but it isn't always so. In early EV rallies, a problem developed when diehard competitors would circle for hours at 20 mph, conserving their energy for the maximum distance. This problem was solved when rules were instituted requiring a minimum lap speed. This was enforced by a maximum time allotted per lap, or (in the high school class at Phoenix) by a pace car.

Some races combine the criteria to keep the speeds up to interesting levels. In this version, the winner is the first car to cover a specified distance, OR the car with the most mileage after a specified time, whichever comes first.

Then there's the time-and-distance rally. This is more of a competition than a race, since there is no advantage to being the fastest car. Instead, precision is paramount. The team consists of a driver and a navigator, driving over public roads in normal traffic. A rally is like a time trial in that cars start at intervals, with each being clocked separately.

The team is issued a set of directions to various checkpoints on the course in a kind of "connect the dots" game. For novices, this may include a map and written instructions, and the course may be clearly marked by signs along the road. But for serious ralliers, there are only enigmatic instructions such as "drive at 30 mph for .7 miles, then turn left at the white house." Stop watches and accurate odometers and speedometers are essential.

The car is validated by judges at each checkpoint. The goal is to cross the finish line at a precise moment—for example, exactly one hour—after starting. Points are lost for being too early as well as too late. This is a very cerebral event, and not for everyone.

Different Strokes

Looking back over these topics—type of car, type of course, and race format—you can see that there is no such thing as a generic race car. Instead, there are dozens of subtle combinations of these factors.

Next month let's look at some of the things these different kinds of racers have in common such as special equipment for the car and the driver, driving techniques and etiquette, and what those flags mean. If you watch EV racing, your enjoyment will increase as your understanding of the finer points expands. If you haven't been interested in EV racing, you just might find yourself intrigued enough to check it out.

Access

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Lightning Strikes!

Richard Perez

On July 29, 1996 a severe lightning storm ran rough shod over our neighborhood. It was early evening. Karen and I were visiting with my brother, Craig and his wife Charlotte, and my sister, Nina and her son Taylor. Craig and Charlotte had flown out from Atlanta, Georgia and Nina and Taylor from Arivaca, Arizona. We were having a family minireunion for the first time in years. We were a happy chattering crew—the tequila flowed and the stereo blasted out the Grateful Dead to accompany our festivities. We were having such a good time that the massive buildup of thunderheads went unnoticed.

About 6 PM, just as the Grateful Dead launched into the song, “Fire on the Mountain”, I saw that large thunderheads covered the sky. A hard rain, blasted by gusty high winds, riveted everything around us. Thunder and lightning exploded with a continuous roar. Like most woodsie folks, we reflexively counted the seconds between the flash of lightning and its report. This was a big storm and it was right on top of us!

We heard our neighbor, Jim Murdock (WD6EEY) calling us on the 2 meter ham radio. He’d seen a big tree take a direct hit less than a mile from his house (and about two miles from our place on Agate Flat). This hit had started a fire. My brother, Craig, HP Crewmember, Ben Root, and I gathered up the shovels, the 2 meter handitalkie, and roared off in the truck to fight fire.

As we crested the steep lip of Agate Flat we could see the smoke. The fire was about 300 yards off of the road. We ran out and attacked it with shovels. A bolt of lightning had stuck a 60 foot tall Ponderosa Pine tree and french fried it. The bark on the tree was split and charred. Fire had spread for about ten feet around the tree and we attacked it with the shovels. With a large crew, Jim, his wife, and two of his teenage children, and the Agate Flat crew of three, we soon stopped the fire from spreading on the surface. A large dead snag beneath the tree was well aflame and the fire was spreading through the tree’s roots beneath the ground. I called Karen on the ham radio and asked her to telephone the local fire fighters. We needed water and lots of it.

Karen reported that our radiotelephone was dead—no dial tone. Jim Murdock’s phone, which is a hardline system, not a radiotelephone, was also dead. As luck would have Kathleen Jarschke-Schultze (KB6MPI) was returning from a trip to Ashland and heard our chatter on the ham radio in her car. She stopped at the California Department of Forestry (CDF) office in Hornbrook and reported the fire. CDF dispatched a fire truck and a crew.

Meanwhile we had managed to contain the fire, but not to put if out. We dug around its periphery swatting fires spreading underground in the tree’s roots, all the while making jokes about who brought the marshmallows and burgers. About sundown, the CDF crew arrived with water and we left the fire to the professionals.

We returned home, smelling of smoke and covered with soot, to a fine dinner prepared by Karen, Charlotte, and Nina. All in all, we were pretty proud of ourselves—we had fought the fire and beaten the storm. Little did we know….

The next morning we awoke to more thunder and lightning and once again, it was right atop us. I had sprained my ankle on a talus slope beside the fire and hobbled downstairs to view the unusual, early morning thunderstorm. The first thing I noticed was that neither of our two axis electric Wattsun trackers were facing where they should be facing. The early morning storm started several fires in the immediate neighborhood and the fire fighters were promptly all over them. Being laid

up with an ankle that looked like a grapefruit, I passed the time by summing up the damages.

A quick test of the radiotelephone (R/T) system showed me that our base unit, located at the telephone line six miles from Agate Flat, was not working. Ben and Karen jumped in the truck and went to Stan Krute's homestead were the base R/T is located. As soon as they opened the R/T shed, they knew that the situation was serious. The unmistakable aroma of crisply fried electronics wafted from the shed's open door. Yep, it's dead all right. There were components blacked into soot on the circuit boards and it looked like the entrance point of the lightning transient was the telephone hardline. A quick check, via ham radio, of the neighborhood began locating more bodies of dead phone equipment. At Jim Murdock's house, the lightning had fried just about everything that was even vaguely connected to the telephone hardline. Jim lost a modem, the 486 computer connected to the modem, and a FAX machine. Stan Krute and Bob-O Schultze lost a modem each.

Three Wattsun trackers, two at Home Power and one at Jim Murdock's, had dead control heads. We checked the fuses in ours, the flat plate array had blown fuses and reblew fuses when we replaced them. The Midway had good fuses and still refused to track. We used our remote Wattsun steering box to position the flat plate array south. Since the Midway is a concentrating array it requires constant tracking to function. We drove the Midway north and parked it—no power here until the control head was fixed.

And home power systems were not the only ones effected by this storm. There is a large, ≈150 kV, power line crossing Agate Flat. Evidently, this power line took a direct hit. Several wooden power poles were charred and smoldering. Pacific Power sent out a crew and determined that overall 13 poles had been damaged by the strike and the bill to fix them would be in the neighborhood of $250,000. I didn't feel so bad about our damages.

We bundled up the dead equipment and shipped it back for repair. Many thanks for the fast service from Carlson Communication. They fixed our dead OptaPhone (as in very dead—$750 dead) and returned it to us in less than a week. Special thanks also to Ron Corrio at Wattsun for promptly fixing all the dead control heads in the neighborhood. Jim got his back in a couple of days, while we waited a bit longer because our Wattsuns are ancient (one is serial number 3 and had performed flawlessly since 15 May 1991). We've sustained many lightning storms here on Agate Flat, but this was the worst and the only one to destroy any of the neighborhood's electronics. I'm proud of the OptaPhone and Wattsun folks. They fixed our stuff promptly while we're still waiting for any action from the larger companies that made the modems.

All this has spurred my interest in lightning protection. Lightning contains unimaginable power. While I know of nothing that fully protects us from a direct strike, there are many things we can do to make that strike less likely and to protect ourselves from near strikes. To this end, please find an article following this one, by Mick Abraham, about some things we can all do to minimize lightning damage. Please consult the HP Index and read all articles about system grounding. Lightning protection begins with good grounding.

One abiding lesson of this series of storms and fires is the importance of independent, portable communications. During times of danger requiring immediate action, you can't beat radio. Every rural neighborhood should have some sort of local radio network. It could be Citizen's Band (CB) or as in our case Amateur (Ham) radio. What is important is that the network be used (as in monitored) all the time and that the network be independently powered (all radios up here run on PV/battery systems). Without Ham radio we would not have been able to call in our local fire fighters. Without our radios we would have had no communications for days while the phone company fixed the lightning damaged lines.

The final abiding lesson is never listen to the Grateful Dead's "Fire on the Mountain" during thunderstorms.

Access

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Surge Arrestors for Lightning and EMP Protection

Mick Abraham

The numerous *Home Power* articles on system grounding point out the importance of lightning protection. Certain environmental and climatic conditions seem to indicate that lightning activity is on the increase.

Home power systems are particularly vulnerable to lightning surges. Racks, trackers, and wind towers sometimes think they are lightning rods. Solar arrays with numerous interconnections provide a large capture area for surge energy. The result can be dangerously high voltages and static charges in the system.

You may have seen the "spice bottle" sized surge protectors at the local electronics store. These consumer-grade units are low priced, but there is a whole world of industrial-grade protectors that you'll never find in a blister pack. Power companies, the military, and TV and radio stations demand high performing spike arrestors and grounding systems. Industry has responded, and with a little ingenuity, home power systems can achieve similar levels of protection.

Shunt Protection

There are two basic kinds of surge arrestors. Shunting type protectors don't do anything until a surge occurs. When they sense excessive voltage they momentarily switch the spiked line(s) to a direct or indirect earth ground. The turn-on voltage for a particular suppressor must be specified when you order it.

Shunting protectors tend to share part of the surge with the equipment you're trying to protect. This is acceptable for most non-electronic equipment but may not adequately protect sensitive electronics.

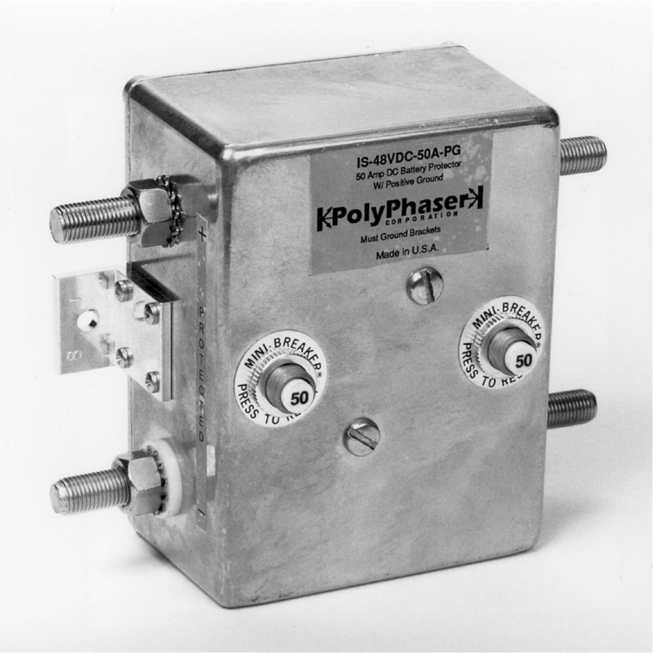
The shunting protectors tend to be lower cost. For example, the LA110V lightning arrestor from Ananda Power Technologies retails for $49. The LA100V is a Silicon Oxide Varistor (SOV) especially manufactured for use in low voltage DC systems. The LA100V protects the system by clamping the voltage at 100 VDC and is rated to dissipate 50,000 Amps and 750 Joules of energy. This arrestor responds to surges very quickly and can clamp 10,000 Amps within 10 nanoseconds. The LA100V provides both differential protection (when there is 100 V between system positive and system negative) and common mode protection (when both system positive and system negative are 100 Volts above ground). This SOV type protector contains a harmless white powder, silicon oxide, which gradually melts as it absorbs surges. If the surge is above the rating of the LA100V, the case of the unit will rupture indicating the need for replacement.

In-Line Protection

The other basic protector design is called in-line (or series). These units actually process the power that travels through them under ordinary circumstances. You must respect their current limitations and you must specify ac or DC in addition to the turn-on voltage. In-line protectors impose a slight reduction in output voltage. These protectors do not tend to share the surge with your equipment, and may be indicated where electronics are involved.

PolyPhaser Corporation makes an in-line protector for solar module (or other DC) installations which drops 0.3 Volts at its 30 Amp maximum. 0.3 Volts represents

Below: The LA100V shunting type surge arrestor.
Photo courtesy of Ananda Power Technologies, Inc.



Above: Series-type surge protector for direct current; NEMP rated. Photo courtesy of PolyPhaser Corp.

about 2% power loss on a 12 V system, or 1% on a 24 V system. This unit retails for $89.95 in negative or positive ground, or $104.95 in a floating ground model. A 50 Amp model is also available.

In some cases the floating ground model is most appropriate, even on negative ground systems. This is due to the National Electric Code (NEC) requirement that the connection between the negative and the earth must occur at one and only one point.

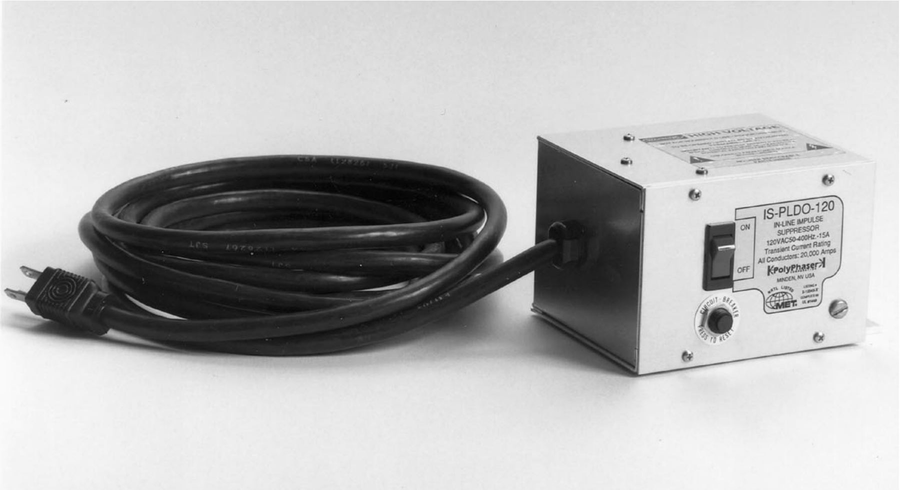
Incidentally, if the floating ground protector is installed on the array side of the PV disconnect switch, it solves the problem of ungrounded array cables when a double-poled disconnect switch is opened. If an overvoltage appears on these lines, it will be momentarily switched to earth by the protector. (Note: depending on your electrical inspector's interpretation of the NEC, the array disconnect switch may not have to be double-poled. Some advise a single-pole disconnect which would open only the ungrounded conductor, so the array wiring can remain grounded at all times.)

In selecting DC protectors for solar array (or other charging source) leads, pay attention to the turn-on voltage of the device you are considering. Many 12 Volt suppressors start protecting at 17 or 18 Volts, which is less than the open circuit voltage of many solar modules. Such a protector will go to work every sunny time the array to battery connection is switched off, whether by an automatic regulator or manually operated switch. This could shorten the life of the protector and is also an NEC code violation. The surge arrestor should not activate when it senses an open circuited solar array or other charging source. This means that a 12 Volt system may wind up with a protector that is labeled for a higher system voltage.

AC protectors can be of either shunting or series design. Telephone lines, coaxial cables, and other things like wiring to a submersible pump can also carry induced surges into your structure. These are sometimes less of a threat because the incoming wires are smaller and therefore have more impedance. Coax cables are shielded so that their central conductors are less sensitive to nearby electromagnetic fields. Telephone company wires sometimes have moderate surge arrestors installed already. Even so, total hardening against lightning entails protection of these leads, as well. Special protection devices are available for all of these areas.

Regardless of the quality of surge suppressors you use, the level of protection against lightning will be no better than the grounding system they work with. Remember that lightning is trying to reach the earth. Your job is to give it a quick and easy way to do that without it going through your inverter, charge controller, etc.

Surge professionals recommend less than 5 ohms resistance between your ground rods and the earth. It's not unusual for a serious installer to exceed the requirements of the NEC.



Left: Professional spike arrestor for 120 vac; rated for NEMP. Photo courtesy of PolyPhaser Corp.

Grounding is a complex subject beyond the scope of this article. See your Home Power index in HP#53 under “National Electric Code, Grounding.” PolyPhaser has a book and video on the subject. These materials are aimed at engineering professionals and they place a particular emphasis on the needs of the two-way communications industry. Nevertheless, they can be a useful resource for those who want to know what the pros know.

Here’s hoping the only surges on your power lines are the kind that keep your batteries charged!

Access

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Don Loweburg and Bob-O Schultze

Although net metering does not necessarily make PV cost effective, it is a very important strategic element in the future of customer owned distributed generation. In a sense, it guarantees grid access to the very smallest power generators. Through Federal regulation (PURPA), larger independent generators have had that access for years and the changes under restructuring will, hopefully, open the retail market to independent power producers. Net metering extends access to the very smallest independent producers, those who own PV on their rooftops.

Utilities have attempted to stifle the net metering movement in three ways. The first is to impose extra “standby” charges on customer-generators. In California both San Diego Gas and Electric and Southern California Edison were supportive of net metering and imposed no extra charge. Pacific Gas and Electric, on the other hand, did try to charge net metering customers a fee over and above the connection charges that everyone pays but were successfully beaten back by the California PV Collaborative and bad press. An extra charge is totally unjustified. Customers already pay a “wires” charge as part of their bill. Furthermore, distributed generation provides an added value to the grid system operators.

The second way utilities slow down net metering implementation is through bureaucratic foot dragging and inaction. Customers wishing to intertie their RE systems find little support (read “none”) at the local level when they go to sign up.

The third, and last obstructive maneuver identified so far, is at the technical level. Cumbersome and expensive interconnection requirements may be imposed. Assessment by professional engineers may be required in addition to expensive system testing. These requirements were usually justified on the basis of safety.

Since there are now numerous off-the-shelf qualified and tested synchronizing inverters available and the NEC addresses the placement of disconnects and safety devices, these outdated requirements are no longer required. Both the issue of safety and other technical considerations were addressed in the Model Interconnect Agreement that was carefully constructed by a sub committee of the California PV Collaborative which included representatives of the PV industry, the California Energy Commission, and Southern California Edison.

Tom Starrs (the author of the California net metering law) has pointed out that the Bell companies (the old communications monopolies) attempted the same thing years ago in order to keep customers from using their own phone equipment. The real issue is that utilities don’t want you to do it. Rather, the utilities want to own distributed generation and use your rooftop while charging you an extra charge for having it there! This little jewel goes under the name “Green Pricing”. You might well ask, Who gets the green $$?

On Grid but Off Line

Twice during this last Summer the Western power grid went down. These were outages due to systemic failure; failure that left millions of people without power for many hours and caused unknown millions of dollars loss. Though we live off-the-grid, Cynthia and I vicariously experienced the last outage. Our first hint that something was wrong happened when our favorite listener sponsored radio station went off the air. Changing the dial we found many more dead spots on the radio. Soon, the stations’ back-up generators returned them to the air and we spent the rest of the afternoon and evening listening to talk radio and the phoned in direct reports from citizens. The callers were upset. Recall that the outage occurred during a heat wave. People drove around in their cars using the air conditioning to beat the heat. Their homes were without air conditioning and unbearably hot. Realizing they needed gasoline they found the stations shut down. There was no electricity to pump gas. They went home

to find that there was no water because municipal pumps were out. Without electricity many could not cook. Most restaurants were closed. The refrigerators were getting ripe. It was eerie to tune the radio to stations in Utah and Nevada and hear similar reports.

What happened?
From the reports of power station operators (several phoned in), frequency and voltage fluctuations began occurring in mid afternoon and instead of dampening got worse. At different points in the system circuits began automatically protecting themselves by disconnecting. This had a cascading effect and soon the whole network was, for the most part, down. The system had become unstable under extreme load (due to the heat).

At first glance the Western power grid is an engineering masterpiece. Highly interconnected, it allows large amounts of power to be moved over large distances. At the core of this system are the large central power plants. The historical pattern has been ever larger facilities sending power over larger and larger distances. This paradigm has reached its zenith. With ever larger sources pushing power over even greater distances, network stability (more to the point, instability) has become an issue.

Air Conditioning vs The Salmon
Raising the spectre of "a national security risk", Western power grid officials have intimidated the US Dept. of Energy and the National Marine Fisheries Service into allowing the sacrifice of juvenile salmon to giant hydroelectric turbines on the Columbia River. During an emergency meeting in Portland, OR immediately after the second western states power outage, the Bonneville Power Administration got the green light to stop spilling water over The Dalles Dam in northeastern Oregon because of "serious power supply problems facing the West." The Western Systems Coordinating Council, a consortium of utilities that own and operate the transmission lines that feed most of the Western states, the DOE, and even the FBI are looking into "the causes of this disturbance."

It turns out that one of BPA's major customers is Pacific Gas and Electric (PG&E) who serves Northern and Central California. PG&E was strapped for power because a couple of their own nuclear power plants at Diablo Canyon were still out after the first power outage. This is the same PG&E who is dragging feet and fingernails in an effort to delay having to buy PV produced power from residential customers under the California net metering law.

Frankly folks, this level of control over so many of our lives by the power brokers scares the bejesus out of us. We're thankful every day to be grid independent. Never mind the cost, like any good tool, it's money well spent.

Into the Future
The emerging pattern is distributed generation. New sources of distributed generation will augment the current networked system adding the valuable essential element of system stability. Returning to a comment a few paragraphs back, it's clear that net metering customers add value to the grid by virtue of their distributed generation benefits and they should not be charged additional standby charges.

It's interesting to imagine a different scenario during this last heat wave and power system failure. What if throughout California and the Southwest perhaps 1% of the customers had rooftop PV and or solar water heating? Would this have made a difference? We believe so. Large systems on the verge of instability (oscillation) can be dampened with very small amounts of negative feedback (distributed generation). For this reason, expect to hear a lot about distributed generation and why utilities must have market access. But remember, there is no basis whatsoever to extend monopoly privilege to renewable distributed generation. These services readily can and should be provided in the free market. We should all be saying to the utilities; monopoly of the power grid may have been a necessary evil once. But that was a long time ago, get over it.

Net metering testimonial
Dave in Central California reports that the outage had "little effect" on him. He has battery back-up for his grid connected system. "Our power bill for the last month was $45; previous month was $40. Usually with our normal type of living our power bills were $100+." Dave has notified the local utility that he is grid connected and is engaged in net metering. "I recently wrote PG&E requesting to be put on the rate schedule, using the info you provided me. So far, I haven't heard back from them." Stay tuned.

California PV Collaborative
The California group is increasing efforts to promote net metering nation wide as well as in state. Tom Starrs, who crafted the California bill, and possibly others, may be available to promote net metering with support from Solar Energy Industries Association (SEIA). Also, SEIA will be supporting the creation of a web site with net metering information, possibly at the CREST or EREC sites. If any reader is presently engaged in net metering or having problems getting it, IPP would like to know about your case. Please contact us via phone, fax, letter, or email.

Howard Wenger of Pacific Energy has just completed an interesting study to be published by the California Energy Commission. The work is an extensive study of the economics of grid-connected PV for both utility and customer sited PV in the Sacramento Municipal Utility District. SMUD was one of the first utility districts in the country to dump their nukes.

Some study conclusions: the total or "stacked" benefits for distributed PV double the value of PV to SMUD; utility standby charges for net metering substantially negate the value of net metering to the customer; 400 MW of rooftop PV generation is possible in the SMUD service area; and, cost effective PV at $3.60 per watt could be possible by 2003 based on the existing price decline curve.

These findings, though intuitively obvious to many intimately involved with PV, are important because the rigorous methodology makes the conclusions arguable to the not so well informed.

Restructuring

IPP continues to follow restructuring issues in California and elsewhere. Restructuring presents both risks and opportunities for renewables. Risk, because in the short term, renewables could be priced at a disadvantage if valued in terms of energy alone. Opportunity, since the stacked benefits of renewable distributed generation may be very much in demand in a structured energy environment.

In past issues we have discussed the Renewables Working Group (RWG) operating under the mandate of the CPUC. As I write, another participant has emerged, the California State Legislature. It is not clear at this time which body will prevail. The issues remain the same and IPP will continue to advocate the protection of renewables and insist that renewable distributed generation (especially rooftop PV) remain in the hands of the ratepayer/owner and free of monopoly market distortion.

The California Energy Commission maintains a web site that contains the latest reports of the RWG in addition to information on restructuring and links to sites on renewables and many other interesting subjects. Go to:

http://www.energy.ca.gov/energy/restructuring/renewables

Access

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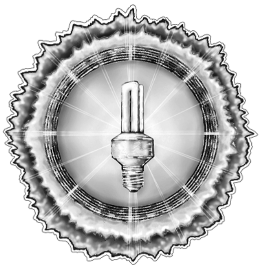
Home Power's Business



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Codes and Standards: Cost and Performance Impacts

John Wiles

PV systems and components may be assembled from components that comply with established standards, and they may be installed in a manner that meets local and national code, or they may be assembled and installed in a manner that does not comply with any code or standard. Users, designers, and manufacturers of PV systems and components make this choice every time they make, install, or buy PV systems. There have been concerns in certain segments of the PV community that compliance with codes costs too much and imposes performance penalties. These concerns are addressed in the following paragraphs.

Introduction

Terrestrial PV power systems are well into the second decade of widespread application. With the number of PV systems increasing, there has come an expansion in the number and types of codes and standards that apply to PV systems. These codes and standards impact the design, installation, performance, and costs of PV systems.

Many systems use components manufactured and tested to the various standards published by the IEEE, the National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories (UL). On the other hand, there are numerous PV components, both small and large, manufactured without adherence to any standard. While installations with either set of components may result in a similar degree of customer satisfaction, the use of listed (built and tested to a standard) components is rapidly becoming the established and legally required practice.

The National Electrical Code (NEC) and supplemental state, county, and municipal electrical codes govern the legal installation of PV power systems just as they govern the installation of other electrical power systems. Many PV systems are installed in a manner that meets the applicable codes. These systems are required to have components manufactured and tested to UL Standards.

Standards and codes are not developed arbitrarily. They are the product of many people working countless hours using professional experience and a knowledge of the current technology to write requirements and guidelines that will result in safe, durable, and high performance PV systems. These standards and codes are the joint product of a collaboration among the PV industry, standards developers like UL, the academic community, electrical inspection officials, and government agencies with input from the end user.

There are costs associated with installing systems that comply with the various codes and standards. There are also benefits for installing such systems, in terms of increased safety for users and maintainers as well as the potential for enhanced performance. On the other hand, there may be penalties for not installing code-compliant systems such as equipment failures, safety hazards, and failure to obtain occupancy permits.

Codes and Standards

The system (and equipment) used for the generation, distribution, and end use of electrical power in the United States represents one of the most complex and safest systems in the world. The U.S. electrical power system performance and safety record is judged outstanding. This record is the result of a process of developing and applying safety and performance codes and standards to the electrical power system for over a century.

The end result is that the electrical utility industry uses a number of standards established by the IEEE for the generation, transmission, and distribution of electrical power. At the end-use facility, both the NEC and IEEE Standards apply to the equipment and installation of electrical systems.

The National Electrical Code (NEC-ANSI NFPA 70), published by the National Fire Protection Association (NFPA) establishes requirements for the installation of field-installed and wired electrical power systems. The NEC was first published in 1897 and has been revised and updated on a regular basis since 1911 by the NFPA.

The NEC does not cover electrical utility facilities used for the generation, transmission, and distribution of electrical power that are owned and operated by the utility on utility property. Neither does it cover electrical power systems in automotive vehicles, recreational boats, or railway cars. It does, however, cover house boats and recreational vehicles. Voltage ranges from zero to 40,000 volts and frequencies from direct current (dc) to radio frequencies are covered by the code.

The NEC Committee (charged with developing the code) is composed of a Technical Correlating Committee supervising and integrating the results of twenty NEC Panels that study, evaluate, and revise the entire NEC (over 1000 pages) every three years. The panels are composed of volunteer professionals representing the NFPA, UL, the International Association of Electrical Inspectors (IAEI), electrical equipment manufacturers, electrical installers unions, the academic community, and various other involved parties. Proposals from these panel members, other interested parties, and the general public are used to revise and update the NEC.

Photovoltaic power systems are addressed specifically in Article 690 (10 pages) of the NEC, but 80-90 percent of the rest of the 1000-page NEC applies to PV systems as it does to all electrical power systems. The PV industry, through the support of the Solar Energy Industries Association, has a

member on Code Making Panel 3 (CMP-3) who votes on items dealing with PV systems in Article 690 of the NEC.

The NFPA has tasked CMP-3 to establish a Task Group to specifically address issues associated with PV systems for the 1999 NEC. This seven-person Task Group is supported by a Technical Review Committee of about 30 people representing all phases of the PV Industry. They are dealing with the code changes that will be required to implement advanced technologies such as those associated with the AC PV Module and Building Integrated PV Systems. The Task Group is also addressing the safety requirements associated with dc electrical systems that have not been updated in the NEC in recent years. The Task Group has been meeting about three times a year, and the activities will culminate with a set of proposals for the 1999 NEC that will be forwarded to the NFPA in November 1996.

While the NEC is just a published document, it has been adopted as a legal requirement in more than 40 states and in most large cities throughout the U.S. The NEC is supplemented by local jurisdiction codes in many areas. Enforcement of the NEC, where it has been adopted, varies significantly. In some areas only permits are required and the installer is charged with code compliance. In many areas, a comprehensive, rigorous inspection system has been established. The more intensive, extensive applications of the code are found in urban areas where high population densities have dictated stricter safety measures.

The NEC represents a set of installation requirements, and establishes requirements for the equipment used. All equipment installed under NEC requirements must be examined for safety. The electrical inspector or other authority having jurisdiction (AHJ) usually interprets this as a requirement that all equipment be tested and listed. Testing and listing is a formalized process, carried out by a few major laboratories, that verifies that the equipment meets standards written and published by UL. The NEC also requires that all equipment be installed in accordance with the conditions established by the listing, any applied markings or labels, and the instructions supplied by the manufacturer. Finally, the NEC requires that good workmanship be used and the inspector makes evaluations based on the experience with numerous non-PV residential and commercial electrical power installations.

The National Electrical Manufacturers Association (NEMA) publishes a number of standards that deal with the manufacture of equipment enclosures, wiring devices (plugs and sockets), batteries, conduits and raceways, and connectors, among other things. The NEMA and UL standards are both written to harmonize with the NEC, and much of the non-PV-related equipment such as enclosures and raceways are made to NEMA Standards.

Federal, state, and local governmental agencies usually specify compliance with certain IEEE Standards as well as with the NEC. These IEEE Standards deal with battery system design and installation, inverter performance, utility-intertie specifications and, in the near future, PV module qualification. The IEEE Standards establish performance as well as safety requirements.

The Impact of Using Listed Components

There are cost increments inherent in installing PV systems that comply with the NEC. In many jurisdictions, installation of any electrical system requires that permits be applied for and inspections be conducted on the finished work. The local jurisdictions also require that the installer have the appropriate business and professional licenses. Admittedly, permits and licenses cost money and, while the authority having jurisdiction may have less knowledge of PV systems than the installer, there is a strong case for having these PV electrical power systems permitted and inspected like other electrical installations. PV systems are used by and accessible to the untrained general public and must meet the necessary minimum safety standards. The permitting and inspection process provides an extra layer of safety and liability insurance to the installation. In many parts of the country it may be possible to install a PV system without a permit, but to do so in other areas is to break the law.

The NEC requirement that all electrical equipment be listed requires that standards published by UL be used to evaluate the safety of products used in the United States. Products are tested against these standards by UL, ETL, and other testing laboratories recognized by the local jurisdiction. Such mundane items as the twenty-five cent cover plate for the electrical outlet are listed. The costs associated with testing, listing, and follow-up services by these laboratories can vary greatly depending on the product. A PV load center made entirely from components that are themselves listed, may be relatively inexpensive (less than $10,000) to have tested and listed. A PV charge controller that uses components that are only recognized (a less rigorous category of certification than listing) by the testing laboratories in a newly designed (non-listed) enclosure may require additional testing and additional costs before a listing can be issued. A PV component, such as a PV module, that is manufactured mainly from new (unlisted and unrecognized) components may require significant amounts of testing. Such testing may take more than a year, require the services of many people working in a number of different testing laboratories, and is not cheap.

It is not always easy to conform with the requirements of the published standards or the listing process. The component design must be relatively mature since any change, however small, in the materials or design must be reevaluated by the testing laboratory. Another point is that, unfortunately, some current PV components are not able to meet the safety standards without a complete redesign. The use of exposed terminals and flammable materials are generally not allowed in electrical power equipment.

The listing of all components is an NEC requirement and is being enforced by increasing numbers of jurisdictions. If no listed equipment is available in a particular category, the inspector may issue a waiver that allows unlisted equipment to be used. For PV systems, however, there are now listed components available in nearly every category, including source-circuit combiner boxes, load centers, charge controllers, and inverters, but excluding gasoline/propane/diesel-driven generators and batteries which are generally not listed.

Even in the non-listed category of batteries, there are some manufacturers that are making batteries that are recognized by UL. That means the batteries are made to the manufacturer's specification (not to a UL Standard) and UL verifies that the batteries are consistently made to that specification.

While the cost may not be insignificant, the listing process does provide several significant advantages. PV systems that use listed components have access to a greater market than do systems with non-listed components. Listed components provide a well-defined liability trail should a PV system or component fail. When greater market penetration is added to the reduced liability issues associated with marketing a listed product, the costs of such listing are not at all imposing. In fact, the greater sales volume of listed products may allow the manufacturer to keep prices lower, provide newer technologies, and better customer services. Implicit in the listing process is the fact that a third party (the listing laboratory) is watching the manufacturing process very carefully and is very interested in hearing about and correcting faulty products.

The Impact of Complying with the NEC

Compliance with the NEC requires that proper types of cables, conductor sizes, overcurrent devices, and disconnects be used. A PV system could be assembled meeting none of these requirements (and many have), but safety and common sense seems to indicate that at least these items should be used and used correctly.

Cables

Increasing the size of the cable to the next larger size to meet the temperature-derated ampacity requirements of the NEC may increase the cost of the system as the table below shows. Using a wet-rated cable such as a THWN-2 conductor in conduit instead of a damp-rated conductor like THHN may cost a little more, but many cables are dual rated THHN/THWN-2 at the same cost as THHN. Most USE cables, are triple rated USE-2/RHH/RHW-2 and can be used in free air as module interconnects and as conductors in conduit.

Typical Cable Costs

AWG	Type	Cost per 200'
12	THHN	$ 9.00
10	THHN	15.00
8	THHN	23.00
12	THWN-2	$ 11.00
10	THWN-2	17.00
8	THWN-2	28.00
12	USE-2	$ 19.00
10	USE-2	26.00
8	USE-2	42.00

While large cables cost more than smaller cables, the use of larger cables results in lower voltage drops and less power loss and this may offset the added costs of the larger cables over a 20-year life of the PV system. The table below assumes that 25 amps of current is flowing from the PV array to the rest of the system over a 100 foot (one-way) length of cable. Number 12, 10, or 8 AWG cables could possibly be used to carry the 25 amps of current although the NEC might require number 8 AWG conductors.

The power lost in each cable is shown in the table below. If the modules are about 50 watts each, the number 12 AWG conductor loses about five modules worth of power, the number 10 AWG cable about three modules worth of power, and the number 8 AWG cable about two modules worth of power. With modules priced at about $5.00 per watt, switching from number 12 AWG to number 8 AWG would save about $600 (3 modules x 40 watts/module x $5/watt). The $23.00 price differential for using the number 8 AWG USE-2/RHW-2 is very much less than the $600 worth of lost module output.

Power Losses in 200' of cable at 25 amps

AWG	Current	Ohms/200'	Voltage Drop	Power Lost	Equivalent Modules
12	25	0.396	9.9	248	5
10	25	0.248	6.2	155	3
8	25	0.156	3.9	97	2

Overcurrent Protection

The addition of fuses costs more than using no fuses, but there are few PV designers and installers that would be willing to install a PV system without some type of overcurrent protection. DC-rated fuses cost more than ac-rated fuses. In some cases, DC-rated circuit breakers like the Square D QO breakers cost less than DC-rated fuses and fuse holders. When Square D QO circuit breakers are used on 12-volt PV systems, the total cost of the breaker and the enclosure is usually less than the cost of a similarly rated fuse, fuse holder, and enclosure. The installation of the circuit breaker is considerably easier also.

PV systems with batteries can deliver very high short-circuit current, so the battery circuits should always contain current-limiting fuses to protect other circuits and components. In some cases, these fuses can be eliminated by installing circuit breakers with high interrupt capabilities (such as the Heinemann E-Frame units) throughout the system. Original Equipment Manufacturers (OEM) can implement cost-effective solutions such as these because custom enclosures are required.

Performance Impact

The impact on performance that compliance with the NEC and other standards may have has been the subject of much discussion. Several areas that have received attention are discussed below.

Code compliance requires that several devices be added to the system that may affect performance. The NEC requires that all conductors be protected from overcurrents from all sources. It also requires that disconnects be provided so that all sources of power can be disconnected from the system; and requires that system components can be isolated from all sources of power during servicing. These safety requirements are specified so that the unqualified (untrained, general public) person can safely operate the equipment without electrical shock hazards and that faults in the field-installed wiring will trip the appropriate protective device with little damage to the equipment or surroundings. The NEC

requirements are also designed to allow the unqualified person to reset or replace tripped overcurrent devices without coming into contact with electrically live contacts.

These extra components may create losses in the system. Admittedly, each electrical component that is added to a PV system such as a diode, switch, fuse, or circuit breaker has some resistance that results in a measurable voltage drop and some measurable power loss. In small, 12-volt systems that are used for remote, stand-alone power, these losses may pose problems - especially where adequate attention has not been given to the overall system design. In these systems, night-time battery voltages are normally below 12 volts, and excessive voltage drops can affect the operation of 12-volt, dc appliances.

However, with proper design and suitable components, even in 12-volt systems, these voltage drops and losses can be tolerated. In the larger, higher voltage systems (or systems with inverters), these small losses are not as critical, and the overall design process usually takes them into account. Often, adherence to NEC requirements may result in enhanced, rather than reduced, system performance.

Circuit breakers generally have less power losses and voltage drops than fuse/switch combinations because the circuit breakers have fewer contacts and connections. The use of higher-quality, magnetic-trip circuit breakers can result in less losses than the use of thermal-trip circuit breakers because the internal resistances are lower.

The NEC requires that all conductors be large enough in size (American Wire Gage-AWG) so that they never carry more than 80% of their rated current (ampacity) on a continuous basis. The NEC also requires that conductors be derated (oversized) for the ambient operating temperature, which in the case of PV modules may be as high as 70-80°C. Both of these requirements result in conductor sizes that are larger than would otherwise be installed. The larger conductors yield better performance through lower voltage drops and less power loss as shown in the tables above.

A listing by a testing organization indicates that a component has passed a number of rigorous safety tests which results in fewer problems in the field. While these tests may not be directly related to performance, they do ensure that the components are robust enough to withstand heavy-duty usage (e.g., the interrupting of direct-current (dc) circuits). A robust construction will result in better performance (lower losses) than can be obtained with a component that is not designed well enough to pass the listing tests. For example, a few installers (mostly do-it-your-self homeowners) have used switches rated for ac-only in the dc circuits of PV systems. These switches quickly develop high resistance and fail to operate on the dc circuits. Switches rated and listed for operation on DC circuits do not experience such problems.

The use of automotive electrical components such as the inexpensive plastic-bodied automotive fuse may reduce cost, but may also reduce performance and create significant safety problems. These fuses, and the earlier glass and ceramic auto fuses, are designed to operate in relatively high resistance circuits where the available short-circuit currents are low. They have little interrupt capability and, when called upon to open a high-current fault on a low-resistance renewable energy system, they may explode, melt or catch fire.

Proper grounding of the PV system, as required by the NEC, may also result in enhanced performance from reduced radio frequency interference (from inverters and fluorescent lamps) and better protection from lightning-induced surges. Equipment grounding of the metal housings on 12-volt fluorescent lamps has been shown to improve lamp starting at low voltages.

Surge suppressors (required by the NEC) do not, when properly rated, result in any deterioration in the performance of a PV system and may reduce damage to conductors and equipment when nearby lightning strikes occur. Surge suppressors, when used in conjunction with blocking diodes and the NEC-required overcurrent devices, may provide even more system protection.

Safety vs. Performance

Performance must be balanced with the need for safety and reliable operation. Safety is one of the first requirements for any PV installation that is going to be accessible to the general public. The PV system must be at least as safe as any other electrical power system.

Safety must also be addressed as it impacts the normal operation and maintenance of the system. Although a qualified, well-trained, and experienced person might install the system, there is little reason to expect that operation and maintenance will be carried out by such a person. Since the installer is not continually on-site, the system must stand alone not only in an operational sense, but in a safety sense. Following NEC requirements will result in a system design that can be operated and maintained in a relatively safe manner.

There are, however, exceptions from certain safety requirements in the NEC if it can be ensured that the system is accessible only to qualified persons. This generally points to the PV system that can be fenced and locked so that the general public and untrained persons do not have access under any condition. The NEC does, however, dictate some safety requirements to allow for safe system maintenance, even by qualified persons. For example, there should be adequate working clearances around the storage batteries used in PV systems so that water can be added and the terminals tightened without danger of shocks, acid splashes, or short circuits.

The Bottom Line

In a system using listed components that has been installed following the requirements of the National Electrical Code, safeguards are available that minimize the hazards to persons and the damage to equipment when these unexpected events occur. There will be a battery disconnect switch that can be quickly opened when the batteries in the garage are hit by an automobile. Overcurrent devices automatically open when cables are accidentally shorted by a nail in a wall. The fire department will have access to switches that can be used to shut down the system if necessary in the

case of fires. During normal operation by the untrained, unqualified user, switches are available that allow the batteries, fuses, and other components to be safely serviced.

Systems are not always installed or operated in optimum or benign environments. Insulation on conductors may be accidentally damaged during installation or at a later time by environmental factors or mechanical abuse. Components may be stressed physically or electrically by unanticipated operating or environmental conditions. Thermal cycling, inherent in the daily operation of a PV system, may pose unanticipated stresses on the system.

PV systems may certainly be designed and installed without regard to any codes or standards and without the use of any listed components. Such systems may operate satisfactorily for years. There are no guarantees that a system that is installed with listed components in full compliance with the NEC and other applicable standards will operate reliably and perform at high levels. In each case, the basic system design usually determines the level of performance.

In the non code-compliant system, few, if any, safeguards are available. There may be no way for the user or the maintainer to shut the system down for normal repairs or for an emergency. In the event of system failure and/or damage to property, there is no well-defined legal chain of liability.

In the code-compliant system, the following all work in a carefully defined, integrated manner to ensure the success and durability of the PV system:

- Developers of the standards
- Testing and listing agencies
- Manufacturers of listed components
- Developers of the NEC and other codes and standards
- Licensed installer who follows the NEC
- Permitting authority
- Local jurisdiction
- Electrical inspector
- Insurance company

PV systems that are designed and installed in full compliance with the NEC by licensed installers and fully inspected will receive wider acceptance by the general public and the institutional customer. Photovoltaic power systems have the highest probability of success when they are planned and installed by a team consisting of the owner/user, the PV designer, a licensed installer, and the electrical inspector.

Access

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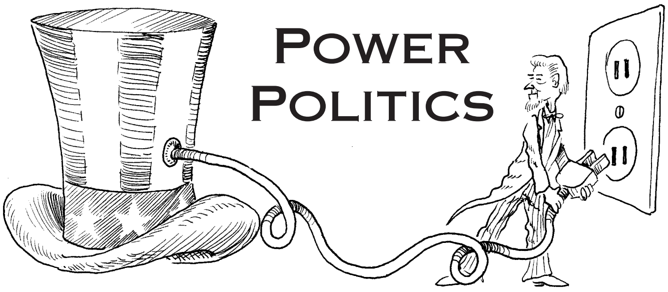

Ralph Nader

Michael Welch

Here we go again, it's election time. Those readers that also watch TV are being barraged with candidates' ads. Unless you are in a community with an important Congressional or local race, then most of the ads will be for or against Clinton and Dole. You won't see any ads for Ralph Nader.

Ralph has yielded to a growing movement to draft him to run for President of the United States of America. In agreeing to do so, he promises not to spend more than $5,000 of his own money and is not raising or accepting any contributions. He will appear as a presidential candidate on ballots in Alaska, California, Hawaii, Maine, New Mexico, Oregon, and maybe more by the time you read this. Other states have organized efforts to get voters to choose Ralph Nader as a write-in candidate.

To the rescue
Ralph has been a willing participant in this drafting. He admits the unlikelihood that he would actually be elected, but is using the campaign as an opportunity to expose the public to the truth of how degraded our political system has actually become. And exposing the truth is what Ralph Nader is really all about.

He's worked for many years on a wide range of projects, all aimed at correcting the wrongs that are prevalent in U.S. society. I suppose that he is most famous for his 1965 book about the automotive industry "Unsafe At Any Speed" that launched him into fame as the U.S.'s number one consumer advocate.

My first experience with him was in the late 70s when Redwood Alliance hired him to speak at a nuclear power "Decommissioning Conference" we organized. He is an honest and straightforward person with a clear vision and the morals to work unimpeded by any drive for wealth and power. At that time, Ralph had been responsible for starting public interest organizations including Public Citizen.

Critical Mass
Public Citizen operates the Critical Mass Energy Project founded in 1974. The name is taken from Ralph Nader's observation that "a critical mass of people can make the critical difference" in winning a sustainable energy future. Public Citizen also operates five other public interest organizations, Congress Watch, The Health Research Group, The Litigation Group (a public interest law firm), Global Trade Watch, and Buyers Up, a home heating-oil cooperative group buying program that acts as an information resource on home energy and environmental issues.

In drafting Ralph Nader to be the Green Party's presidential candidate, the Greens also chose the theme of "Creating Critical Mass" for their August convention. Now, Ralph isn't a Green Party member. He publicly has avoided political party memberships. It seems more like the Greens have joined with Ralph than the other way around. What better match? The ideals and goals of both are parallel.

Ralph has a problem with political parties that is pointed out by what has happened to the two parties that are now in power. He likes to refer to them as "Republicats" noting that there is less and less important differences between the two as time progresses. He calls the system a "duopoly—essentially one corporate party with two heads called Republican and Democrat—each wearing different makeup."

Ralph contends that the lack of differences is getting worse and worse, "Clinton wouldn't qualify for being a liberal Republican in 1970." Neither Clinton or Dole will be addressing the problems that really need to be solved, like how to strengthen democracy, how to counteract the egregious errors of the rich, how to get rid of corporate crime, decaying culture, and how to save the environment from global corporations. "If we want to reform and reinvigorate our democracy so it will last, we have to face unpleasant realities. I'm just a catalyst."

Renewable energy
This is a campaign area that sorely disappoints me. As you may recall from my column in HP52 on the presidential candidates, I lament the lack of a sound energy policy being a part of campaigns. It hurts even

more to find little reference to renewable energy in the materials coming from Ralph Nader's campaign interviews and the Green's own nominating convention. I thought that if any candidate could draw focus to renewable energy, it would be Ralph Nader. Which isn't to say that Ralph and the Greens don't wholeheartedly believe in renewable energy. They do. They're just not making a big enough deal out of it. The only references I came across were antinuclear, which is important, but not pro-renewables.

Of course, Ralph's campaign is trying to keep the big picture in the public eye, not each point that supports it. But still, so many people think that energy is extremely important, and we really haven't heard much about it since the President promised (broken) to dismantle the nuclear industry a couple of years ago. How about it, Ralph, your campaign is about gaining the support of the masses to reclaim their due. Why not rally them with information about the dawning solar and wind age in the US?

Out of the closet

More than once I've been accused of being a member of and promoting the Democrat Party. The truth is that I only become a Demo party member during the primary elections when I switch long enough to try to elect progressive-minded candidates into a party that once stood for the individual instead of the corporation. My true allegiance is with the Greens, it has been for a few years, and I'm proud to announce it to all.

I can see how some of you might have thought me a Democrat. I've often feared the future should environmental and social dismantlers take over both the legislative and administrative sections of our government. I still share those concerns, but like Ralph, I see less and less difference between the two parties each election, and this year it has dwindled to a ridiculously low level.

Risk of change

Our environment will be in deep doo-doo if we elect a President that agrees with Newt Gingrich's efforts to give away our health and safety in exchange for corporate profits. But we're going to find ourselves in that doo-doo anyway, unless we finally make a change in our system. Until now, I've not seen anyone with the ability to lead us past what the duopoly has to offer. I think that Ralph may be that person. It won't happen this election, but the plan is to do what we can to get his foot in the door.

What is the danger of Ralph Nader stealing enough votes from Clinton to get Dole elected? That's been the subject of much discussion in California which is considered a key state in the upcoming election. A lot of it depends upon who you talk to. The White House Chief of Staff says that California environmentalists "are not, when it comes down to it, going to waste a vote." Political strategist Bill Carrick adds, "For every vote Ralph Nader gets that might go to Bill Clinton, there will be five votes going to Ross Perot from Bob Dole's pile."

On the other hand, former California Democratic Party chairman Bill Press said, "Whatever votes Nader gets, he will get from voters who would otherwise vote for Bill Clinton," and also, "Certainly it would be much better for the President for Ralph Nader not to be on the ballot."

Nader doesn't want to play into those numbers-counting games. He'd rather stick to the message, "The purpose of this campaign is not an electoral vote count. It's to broaden the political debate to include an examination of the immense and diverse role of multinational corporate power on our political, economic, and cultural institutions. It's to encourage young people to get into the process and build a political movement for the future. It goes way beyond November."

Wake up

My hope is that this wake-up call will begin a successful effort of change. It is not yet time to give up on the American political system. Ralph Nader believes in our future, or he would not so selflessly throw himself into the betterment of it.

Whether or not you, as a Green, Libertarian, Democrat, Republican, Independent, or whatever, decide that you should risk voting for someone that may be able to effect a change some day, is a tough question. Voting for a non-Republocrat candidate could have a chilling result. But so could the opposite vote. Like I said, Ralph Nader is the only candidate I've seen in a long, long time that has the capability of leading us to change. I'll be searching my soul carefully until election time.

Access

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• The Web: http://www.igc.apc.org/redwood

Public Citizen, 1600 20th St. NW, Washington, DC 20009 • 202-588-1000
• Internet Email: public_citizen@citizen.org
• The Web: http://www.citizen.org/

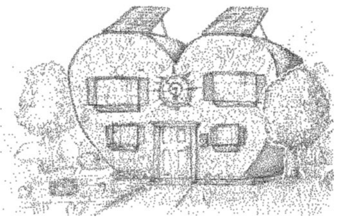
Committee to Draft Ralph Nader for President,
PO Box 3727 Oakland, CA 94609

The Greens/Green Party USA, PO Box 100 Blodgett Mills NY 13738 - 607-756-4211
• Internet Email: gpusa@igc.apc.org
• The Web: http://www.greens.org/

Bill Clinton, 1600 Pennsylvania Ave. Washington, D.C. 20500 • Phone: 202-456-1414 • Fax: 202-456-2883 • Internet Email: president@whitehouse.gov • The Web: http://www.whitehouse.gov/

Bob Dole, 810 First Street NE Suite 300, Washington, DC 20002 • Internet Email: leader@firstdog.com • The Web: http://www.firstdog.com/

Home & Heart



Kathleen Jarschke-Schultze

After what seemed to be a short, intense, hot summer, autumn is swiftly approaching. A great part of living beyond the pavement and the power lines is dealing with the fact that there is no pavement. Muddy roads are a daily winter and spring reality.

Loose Gravel
One solution is to lay a good base of gravel right around the house and parking area. By graveling the driveway and parking area you can keep a lot of dirt out of your house. This is, of course, the preferred option. Unfortunately, the fact that you live way out in the country means that you pay a premium price for gravel and the hauling of it.

Muddy Roads
The same is true of acquiring rock and applying it to your road. The longer the road, the higher the cost. The farther from the quarry, the higher the cost. The type of soil dictates how often you need to replenish the rock on the road. Any culverts or bridges on your road add to the maintenance and cost.

Finally, the number of households on your back road determines how the cost of road repair can be divided up. In our neighborhood we share the cost and labor. This year the road will be worked on by hiring big equipment and the CREW to run it. Timing is also important. The work has to be done mostly when the road is dry. Then, after a few rains, we will bring the Cat back to regrade. This is so the new rock doesn't all get pushed up into the center of the road.

Muddy Feet
Living around all this dirt makes it hard to keep it out of your house. One of our neighbors uses the Asian method of removing their shoes before entering the house. This works because they have a nice deep roofed porch, with seating, to provide a place to remove and keep their shoes. Winter shoes of choice in this neighborhood are knee high black rubber gum boots. These are fairly easy to put on and remove as there are no laces. It's pretty hard for the wet adobe clay to suck the boot off your foot, although it has happened.

Mud Rooms
We had an old porch rebuilt into a mud room last Fall. I am totally hooked. It has been great. We have a bench to sit on to remove your boots or shoes. When you lift the seat of the bench it is the fire wood box, which can be loaded from the outside. Bob-O and Allen keep their ski gear hanging neatly on the wall. There are coat hooks for all the outerwear we use in the winter season. A three tiered shelf keeps our shoes and boots from becoming a pile in the middle of the floor. I store my large telescope out there.

The mud room provides an air lock to the main house. This is really efficient in the winter cold. Now I know it is also important in the summer heat. In the winter the two windows provide more light. In the summer I hang heavy curtains that help to keep the heat out.

Design Savvy
I was talking to Julie Wurl-Koth at the Midwest Renewable Energy Fair this June. We were praising our respective dishwashers when the topic turned to mud rooms. Wisconsin has a lot harsher winters than northern-most California, by a long shot. I could easily see the advantages of a mud room for any house, on the pavement or not.

Julie's husband, Mickey, of Solar Spectrum in Tomahawk Wisconsin, has built a heck of a mudroom at their home. Not only does it hold muddy boots and dripping coats it also has closets for stowing all their camping gear out of season. They have two closets for the gear. One is tall with no shelves so they can hang their sleeping bags full length. Julie says this keeps them nice and fluffy. Shelves and hooks between, then the next tall closet. This closet has shelves which hold the rest of the camping gear.

Like most mud rooms Julie and Mickey's has a bench. The really swell thing about their bench is that by lifting the seat you reveal their built-in recycling center. Mickey has designed an opening under the bench seat that sorts and deposits the recyclables into 55 gallon drums in their garage.

There are separate chutes for white glass, green glass, brown glass, aluminum (with a can crusher nearby), and recyclable plastic. The chutes go down to the garage where the drums sit underneath each chute. When Mickey's ready he can back into the garage and load up the drums for transport to the local recycling center.

Julie chose indoor-outdoor carpet for the mudroom. In the winter the mudroom gets very cold and sometimes freezes. The carpet is not slick and slippery like linoleum would be. I've found that indoor-outdoor carpet is the easiest to clean, either with a vacuum or with a broom.

Better Homes & Shacks
I'm sure our readers have some custom mud rooms. I'd like pictures and descriptions of the things that make your mud room special. If you don't have a mud room and you own your home, consider building one. If you are planning to build, all the better. Design one into your overall plan. You will not regret it.

Staber Sidenote
I noticed when I washed clothes that they didn't seem to be spinning out as dry as they had been. I was washing a couple of loads a day at the time to catch up after the flurry of summer travel. I washed a load and it didn't spin at all, the top of the clothes were still dry. I started the cycle again and waited by the machine.

When the Staber cycles the drum starts to turn and sounds like the theme music from "JAWS". That is normal. That didn't happen this time, the drum didn't turn.

Say Belt In French
I asked Bob-O to check it out for me. He took off the front panel and removed the drum belt. Sure enough it was very frayed in one place. It was barely hanging in there at all! "Yikes!" I thought, "now I've done it. It was all those really big loads I've done. I shouldn't have filled the tub so full each time. Maybe that dog bed was too much." Of course I didn't tell Bob-O that.

I looked in the owner's manual, at the exploded view and found the part number. Bob-O called Staber Industries the next morning. He got one of the Staber brothers on the line. He explained that we needed a new belt. Mr. Staber had us check to see if the belt said "Made in U.S.A." on it. It did.

Staber first used a U.S. made belt in their machines. They had quality control problems. So they changed to a French made belt that has more longevity. Since I have one of the early models I still had the old belt. Mr. Staber thought they had replaced all the old belts on units that had already been sold. He was very surprised my belt had lasted so long. (I didn't mention the dog bed.) He sent me a new belt free. My Staber is now working just like before. I love this machine.

Access
Kathleen Jarschke-Schultze is anticipating home made autumn cider at her home in northern-most California, c/o Home Power Magazine, PO Box 520, Ashland, OR 97520 • 916-475-0830 • Internet Email: kathleen.jarschke-schultze@homepower.org or kjs@snowcrest.net

Julie and Mickey Wurl-Koth, Solar Spectrum, W4622 Kyes Rd, Tomahawk, WI 54487 • 715•453-2803

HAPPENINGS

CANADA
The “Alberta Sustainable House” is now open for public viewing every Saturday 1:00-4:00 PM free of charge. The first of its kind in Canada, the project emphasizes cold-climate state-of-the-art features/products based on the founding principles of occupant health, environmental foresight, resource conservation, AE, recycling, low embodied energy, self-sufficiency, and appropriate technology. Already in place: R17 windows, multi-purpose masonry heater, solar hot water, greywater heat exchangers, LED and electroluminescent lighting, solar cookers, and others. Under development: hydrogen fuel cells, Stirling co-generator, Tesla bladeless steam turbine, and others. Contact: Jorg Ostrowski, Autonomous & Sustainable Housing Inc/Alternative & Conservation Energies Inc, 9211 Scurfield Dr NW, Calgary Alberta T3L 1V9, Canada; 403-239-1882, Fax: 403-547-2671

The Institute for Bioregional Studies was founded to demonstrate and teach recent ecologically-oriented, scientific, social and technological achievements that move us toward ecological, healthy, interdependent and self-reliant communities. For more info: IBS, 449 University Ave, Charlottetown, Prince Edward Island C1A 8K3, Canada; 902-892-9578.

MONACO
The 2nd Monte Carlo Rendezvous of Electric Vehicles, Oct. 17-20, 1996. International EV rallye and exposition. For more info: Editions & Promotions Internationales, 11 Boulevard Albert-I, MC9800 Monaco • phone: 92 16 03 76.

INDIA
International Conference and Exhibition on Village Electrification Through Renewable Energy, March 3–5, 1997, New Delhi, India. The Conference and Exhibition will cover photovoltaic systems, wind systems, remote area power supplies, mini/micro hydro, solar thermal, health, biomass, biogas, rural communications, project management, remote monitoring, and financing renewable energy projects. The Conference will provide an excellent opportunity to meet with the Indian Government, World Bank, and GEF officials, researchers, project developers and financiers and the leading players in the field of renewable energy. For more information contact: Dr Dilawar Singh, Co-chairman, c/CASE, Level 3, 81 St Georges Terrace, Perth, Western Australia 6000, Australia, phone (+619) 321 7600, Fax (+691) 321 7497. E-mail: case@wantree.com.au

PAKISTAN
APSENA Renewable Energy Conference, December 15-20, 1996, Islamabad, Pakistan. Association of Pakistani Scientists and Engineers of North America (APSENA) had its 13th Annual Conference at Oklahoma City, OK during July 26-28, 1996. Members participating in this conference felt that since Pakistan is experiencing an acute shortage of energy due to many reasons, it would be worthwhile to introduce Renewable Energy alternatives to Pakistani citizens, entrepreneurs, and investors to meet the growing demands of energy in that part of the world. APSENA holds bi-ennial conferences in the capital city of Islamabad, Pakistan, the membership feels that it should included American Manufacturers willing to participate in such a conference to display their technologies or products, as there is a potential market for U.S. exporters to supplement energy shortages. CONTACT: Bashir A. Syed, Senior Engineer/Physicist, Member APSENA, Lockheed Martin SIS, at NASA/JSC, Houston, TX Phone: Home: 713-286-3726, Work: 713-244-1738, E-Mail: <BashiraS@aol.com

PHILIPPINES
The 3rd International Renewable Energy Asia Pacific ‘96 (REAP’96) Exhibition and Conference will be taking place in Manila, Philippines, October 7–9, 1996. This three day event for both the conference and exhibition and is dedicated to Solar Photovoltaics & thermal, wind, biogas/biomass and hydro projects in the Asia Pacific region. The conference will focus on marketing strategies, project financing , policies and incentives for the implementation of renewable energy projects in the Asian countries. Exhibitors will display their latest in renewable energy and energy efficiency products and services. For more information contact Michelle Hassall, Project Manager, 5/F 3 Wood Road, Wan Chai, Hong Kong. Tel: +852-2574-9133 Fax +852-2574-1997.

NATIONAL
American Solar Energy Society National Tour of Solar Homes. October 19. Various locations throughout the U.S. For info: ASES 303-443-3130 • ases@ases.org • http://www.ases.org/solar.

Online Energy Info Resources—If you are looking for information on energy efficiency or renewable energy technologies, the US Department of Energy (DOE) has two sources of online access. The Energy Efficiency and Renewable Energy Clearinghouse (EREC) BBS Online Service offers users free access to text files, share and freeware programs and utilities, and a free publication ordering system. The service is accessible via the Internet’s World Wide Web at http://erecbbs.nciinc.com or by modem at (800) 273-2955. The Energy Efficiency and Renewable Energy Network (EREN) is also accessible on the World Wide Web at http://www.eren.doe.gov and provides links to hundreds of government and private internet sites. EREN also offers an “Ask an Energy Expert” online form that allows users to e-mail their questions directly to specialists at EREC. For more information please call (800) 363-3732.

American Hydrogen Association, national headquarters, 216 South Clark Dr, Ste 103, Tempe, AZ 85281, 602-921-0433, fax 602-967-6601, e-mail: aha@getnet.com ”Prosperity Without Pollution” web site: http://www.getnet.com/charity/aha

Energy Efficiency and Renewable Energy Clearinghouse (EREC) is offering free booklets on Solar Water Heating (FS119) and Residential Solar Heating Collectors (FS112)contact EREC: Phone: 800-DOE-EREC (363-3732); mail: EREC, PO Box 3048, Merrifield, VA 22116; e-mail: energyinfo@delphi.com; TDD: 800-273-2957; The information can also be downloaded via the DOE’s BBS at 800-273-2955 or via internet: http://www.eren.doe.gov

Visit AWEA’s (American Wind Energy Association) home page on the World Wide Web. (http://www.igc.apc.org/awea) Visitors to AWEA’s home page can obtain information about the US wind energy industry, AWEA membership, small turbine use, and much more.

Tesla Engine Builders Association (TEBA) provides information about a practical and efficient steam turbine available to the home power producer. The “Tesla Turbine” is the only high power turbine that can be constructed using only simple machining techniques and can operate satisfactorily

using only 100 lbs of steam pressure. For more information send an SASE to: TEBA, 5464 N POrt Washington Rd Ste 293, Milwaukee WI 53217-4925; or visit our WWW site: http://www.execpc.com/~teba or send e-mail to: teba@execpc.com

NORTHEAST

ASES National Tour of Solar Homes—"Solar Energy Makes Itself at Home", October 19, 1996. The American Solar Energy Society has taken over the former Real Goods Solar Home Tour, and NESEA as an ASES chapter , will put homes on display from New York to Maine. Participants will learn from the owners, about many ways in which solar energy can be harnessed in a home. Homes employing both active and passive solar systems will be included on the tour, with an emphasis on conventional looking buildings. For more information contact, Doug Minor, NESEA, 50 Miles St, Greenfield, MA 01301, or call 413-774-6051 ext 12.

ARIZONA

The State of Arizona is now offering a tax credit for installation of all types of solar energy systems. A solar technician certified by the Arizona Department of Commerce must be on each job site. For info contact ARI SEIA; 602-258-3422.

Photovoltaic Design and Installation! Solar Energy International (SEI) announces a hands-on, how-to workshop in Tucson, AZ. The Workshop will take place November 4th through Nov. 9th, 1996 at the Cooper Environmental Science Campus (CESC). CESC is a non-profit education campus dedicated to enriching children's lives through environmental education. Over 6,000 students a year attend classes at the campus. Over the last three years SEI has participated in yearly workshops with the aim of taking the campus "off-the-grid". By the end of this workshop CESC will be completely solar powered. Lodging is available on the site and included in the workshop tuition of $500.00. For more information contact: Solar Energy International, PO Box 715, Carbondale, CO 81623, 970-963-8855, fax 970-963-8866. E-mail sei@solarenergy.org

ARKANSAS

Sun Life is now conducting "Third Saturday Seminars" on inexpensive building techniques. Their focus is to teach home building from materials that can last a thousand years and cost less than conventional wood-framing. These are hands-on, all-day workshops. Contact Loren at PO Box 453, Hot Springs, AR 71902.

CALIFORNIA

1996 North American EV & Infrastructure Conference will be held December 11–13, 1996 in San Diego, CA. The Conference will provide up-to-date commercial and technical information to audiences of all levels. Marketing, government and business issues will be addressed, as well as technical advances made in battery, vehicle and infrastructure development. For more information contact EVAA, 601 California St Ste 502, San Francisco, CA 94108, 415-249-2690, fax 415-249-2699, e-mail: ev@evaa.org

First Ever National Railbike Festival, Sunday October 13, 1996, 10 am to 4 pm Jamestown, California (near Yosemite). Bring your won railbikes and ride in the foothills of California's gold country on the Sierra railroad which runs through Sonora, Jamestown and Chinese Camp. (Riders will have to sign a waiver and ride at their own risk.) Swap railbike stories and compare design. Railbikes for novices will be available. For information call Railbike International, 415-453-8886.

COLORADO

Solar Energy International (SEI) is offering "hands-on" workshops on the practical use of solar, wind, and water power. The Renewable Energy Education Program (REEP) features one and two week sessions, PV Design & Installation, Advanced PV, Wind Power, Micro-hydro, Solar Cooking, Solar Home Design, Cob & Natural Building, Straw-Bale Construction and Adobe/Rammed Earth. Experienced instructors and industry representatives teach how to build homes and RE systems. Learn in classroom, laboratory and through field work. The workshop series is for owner-builders, industry technicians, business owners, career seekers and international development workers. The small, intensive and fun workshops may be taken individually or as a comprehensive program. The cost is $450.00 per week. SEI is a non-profit educational organization dedicated to furthering the practical use of RE technology. Contact: SEI, PO Box 715, Carbondale, CO 81623 or call 970-963-8855, Fax 970-963-8866, e-mail—sei@solarenergy.org

Visit the new National Wind Technology Center operated by the National Renewable Energy Laboratory, just outside of Golden, CO. The facilities assist wind turbine designers and manufacturers with development and fine-tuning and include computer modeling and test pads. Call in advance, 303-384-6900, Fax 303-384-6901.

FLORIDA

The First South Florida Sustainable Building Conference and Exhibition, April 10–12, 1997: For building professionals, regulators, researchers and users. Workshops, seminars and exhibits covering sustainability issues in the planning, design, construction, operation and demolition/or recycling of commercial and residential buildings. For more information call (305) 375-1150, fax (305) 375-1157.

MASSACHUSETTS

Quality Building Council/ Northeast Sustainability Center 1996 Professional Workshops, Thursday, October 24 @ 2:00 pm, Greenfield Savings Bank. Financing Better Buildings—This free session is for the mortgage lenders, realty professional, appraisers, and realtors to learn about purchase and resale issues associated with energy efficiency and environmentally friendly constructed homes. To be followed by a New Home Buyer Seminar for the general public. NSC Energy Audit Workshop Series: Steam Systems Tune-Up—A Building Systems Approach, November 15. Designing Low Energy Buildings—An Energy 10 Analysis, November 22 & 23. Healthy, Energy Efficient Basement Remodeling Strategies, December 13. Ecological Waste Water Treatment: Moving With the Current, January, 1997. Call NESEA for prices and details. Workshops will be limited. NESEA Member eligible for discounts. Also call about our Consumer Lecture Series. For more information contact, Doug Minor, NESEA, 50 Miles St, Greenfield, MA 01301, or call 413-774-6051 ext 12

MISSOURI

The Missouri Renewable Energy Association is a non-profit educational organization, promoting energy sensible technologies as a solution to global environmental pollution. Improved energy efficiency. water conservation, recycling, and composting are just a few of the topics on our agenda. We encourage local government, businesses, schools, and individuals to become involved by joining the MO.REA today. For information contact Ray Wathswski, PO Box 104582, Jefferson City, MO 65110, 573-634-5051

NEW YORK

Solar Energy International (SEI) is offering a special workshop for the convenience of Northeasterners who want to get their hands-on!

PV Design & Installation will be a one week workshop Monday October 14 through Saturday October 19. Instruction

will be conducted at an off-grid location near Woodstock, NY. The workshop tuition cost for all six days is $550. Workshop topics include: Solar site analysis, system sizing, PV modules, controllers, batteries, inverters and appliances, demonstrations, lab exercises and hands-on installation. No prior experience or training is required—everyone is welcome! For more information contact: SEI, PO Box 715, Carbondale, CO 81623 or call 970-963-8855, Fax 970-963-8866, e-mail—sei@solarenergy.org • For local housing & logistical information please contact SEIs local co-sponsor: Larry Brown at Sun Mountain, PO Box 1364, Olivebridge, NY 12461, 914-657-8096.

The New York State Electric Auto Association (NYSEAA) is dedicated to sharing current electric vehicle technology. Monthly meetings, for date and location call Joan at 716-889-9516

NESEA. 50 MIles St, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053.

NORTH CAROLINA

Wind Power! Solar Energy International (SEI) will conduct a one week, hands-on course on wind power. This course will be held Oct. 21–26th, 1996. Mon-Sat 9 am-5 pm. Call SEI, PO Box 715, Carbondale, CO 81623, 970-963-8855, fax 970-963-8866. E-mail sei@solarenergy.org

OHIO

The Great Lakes Electric Auto Association's mission is to contribute to the freeing of the US automobile market from dependency on petroleum through advancements in electric and hybrid/electric technology. For more information: Larry Dussault, GLEAA, 568 Braxton Pl E, Westerville, OH 43081-3019, 800-GLEAA-44, 614-899-6263, Fax 614-899-1717. Internet: DUSSAULT@delphi.com

Solar and wind classes taught at rural solar and wind powered home with utility back-up. Maximum of 12 students. Must advance register. $40 fee per person, $45 per couple and lunch is provided. Please advise of dietary restrictions. Class #1 will be full of technical info, system design, system sizing, and NEC compliance, etc. Students will see equipment in use. Students may also choose class #2 and set-up a system (hands-on training), equipment selection, installation of modules, mounts, controller, inverter, and battery bank. Dates: Oct. 5, Nov. 2, Dec. 7. All classes held from 10:00 am-2:00 pm on Saturday. Call 419-368-4252 or write Solar Creations, 2189 SR 511 S, Perrysville, OH 44864-9537.

OREGON

APROVECHO RESEARCH CENTER offers 3 month training sessions in appropriate technology, sustainable forestry and organic gardening. Classes begin September, January (1 month in Mexico), & March. Daily classes 8:30-5:30. Cost is $500.00 per month, includes room, board. For more info: 80574 Hazelton Rd., Cottage Grove, OR 97424. (503)942-8198

VERMONT

Free PV Workshops for beginners to experts given by David Palumbo of Independent Power & Light, First Saturday of every month at the Palumbo/IP&L PV and microhydro powered off-grid neighborhood. Participant interest will determine which of the following topics will be discussed and demonstrated (as practical): site selection, PV modules, batteries, charge controllers, inverters, lighting (ac & DC), balance of system components, system monitoring and maintenance, water (finding it, developing it, transporting it, pumping it, and getting power from it), snow (living with it, playing with it, and removing it), ponds, living in cold climates, living with our woods, heating with wood, and root cellars. Visit a beautiful part of Vermont and meet people who are either living with renewable power or considering it. David Palumbo has taught workshops in the past with the fine people of Solar Energy International and with the real good folks of the Solar Living Institute.

Call, fax, or write for your reserved spot, information, and directions. 9 am to 3 pm the first Saturday of every month. David Palumbo/ Independent Power & Light, RR1 Box 3054, Hyde Park, VT 05655, call or fax 802-888-7194. This is a freebie so bring your own lunch and coffee. We will supply our own pure drinking water, and a great pond for swimming if you are so inclined.

WASHINGTON

Eco Home Fair '96, October 12–13, 1996, Port Townsend, Washington. Environmentally responsible building materials, methods, and systems will be showcased at the two-day Eco Home Fair '96. The fair, aimed at the end-consumer, will include hands-on workshops and tours of local eco-friendly homes. Ticket prices: Adults-$10, Students under 21 years-$5, Children with adult-free. For information contact Chris Stafford at 630-379-8541.

WASHINGTON, DC

SOLAR 97 American Solar Energy Society Conference. In conjunction with Soltech 97 & AIA Committee on the Environment Symposium. Submittal of papers due by Oct. 1, 1996. For info: ASES 2400 Central Ave Suite G1, Boulder, CO 80301 • 303-443-3130 • ases@ases.org • http://www.ases.org/solar.

WISCONSIN

The Midwest Renewable Energy Association Fall Workshop Schedule. Learn more about energy conservation and renewable energy through experiments and demonstrations. Energy education activities, classroom projects, and curriculum ideas for grades K-12 and youth groups will be explored. Tour alternative energy homes in the area. Co-sponsored by the Central WI Environmental Station, Midwest Renewable Energy Association and WI Center for Environmental Education. 1 UWSP credit available. MREA is a grass-roots, non-profit educational organization whose mission is to promote renewable energy and energy efficiency through education and demonstration. Membership and participation in the MREA are open and welcome to all interested individuals and organizations. Significant others may attend with you for 1/2 price. For more information call or write MREA, PO Box 249, Amherst, WI 54406; phone 715-824-5166, fax 715-824-5399

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for U.S. ZIP codes only, see page 81 for international back issues.

(Sorry, we're out of issues 1 through 10, 12 , 14, 15, 35 and 36). We are planning to compile them into a book. Until then, borrow from a friend. If you have a computer (or a friend with one) download the article you're missing by calling the Home Power bulletin board at 707-822-8640. Or check with your local library; through interlibrary loan, you can get these back issues. Jackson County Library in Oregon has all issues as does the Alfred Mann Library at Cornell Univ.)

Home Power, PO Box 520, Ashland, OR 97520 • 800-707-6585 • 916-475-0830 VISA / MC

Good Books

The Sierra Club Green Guide

Written by Andrew J. Feldman

Reviewed by Ben Root

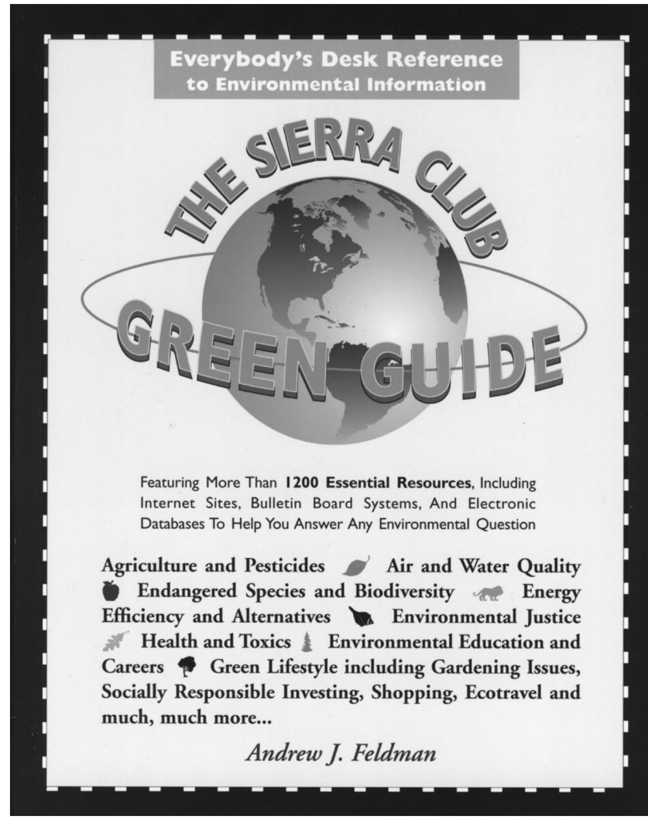
This book is pure reference material; A kind of "Who's-who and how to get a-hold of them" in the world of environmental issues and concerns. Well, I figure that the best way to see if this material is useful is by how easily I can find the *Home Power* entry. The guide is laid out by topic with sub categories by kind. The main topics are:

General
Agriculture
Air
Biodiversity
Energy
Environmental Justice
Health & Toxins
Sustainable Communities
Waste
Water
Architecture
Education
Employment
Gardening
Grants
Investing
Shopping
Travel

Of course, I turn to the Energy section to find the description of *Home Power* with all the important access information, right? Well each topic is divided into "kinds" of entries. For example:

Government clearing houses
Organizations
Internet sites
Commercial online services
Bulletin boards
Directories
Bibliographies
Reference handbooks
Introductory reading
Abstracts & indices
Periodicals

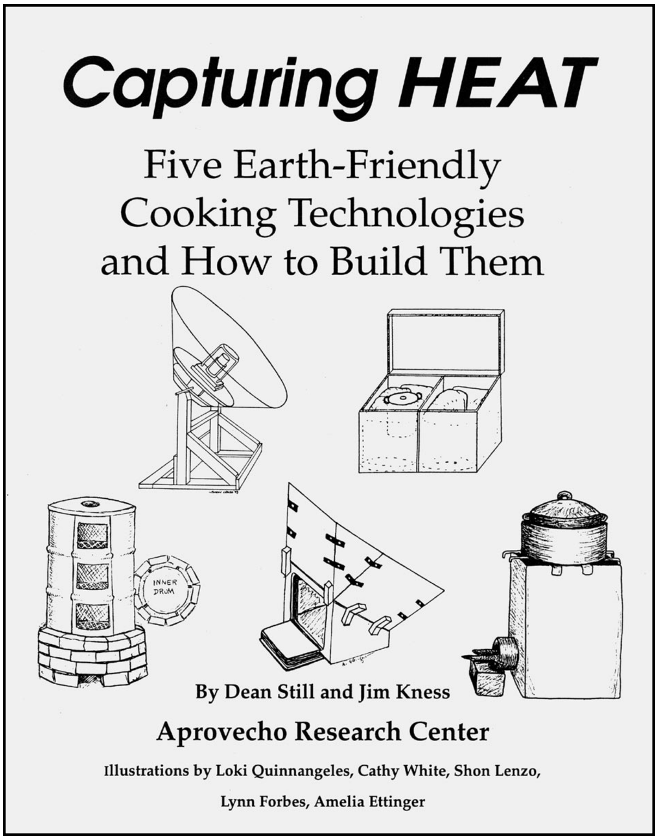
So, *Home Power* must live under periodicals, page 126... Hmmm, here at the very end, under "Other" I find "Home Power, see entry 526." You see, each entry has a number so that it can be cross referenced from other places in the guide. For example our bulletin board is also referenced to entry 526 from the "Energy, Bulletin boards, Other" section. So where is entry 526? Under "Architecture, Periodicals" of course. Maybe they put us there because we are such a hands-on, end-user, do-it-yourself type of publication. Well I don't feel so bad now, after all I did find the entry rather quickly. The cross referencing does work.



As I scan the rest of the guide I find that it is a "top down" collection of entries. It is more likely that you'll find access to one of the "big guys" in a certain field than nitty gritty details. For example, as I went looking for info on residential grey-water systems I found " The National Water Information Clearinghouse" but not "The Happy Hippies Guide to Watering Your Garden While Washing Your Dishes." However, large scale organizations, and their publications, are good places to start the research which will eventually trickle down to the detailed information that you are looking for. In that sense, *The Sierra Club Green Guide* seems rather complete, especially for such a vast undertaking. The guide is 282 pages and contains over 1,200 entries. It is available for $25 through Sierra Club Books, ISBN: 0-87156-402-5

Access

Sierra Club Books, 100 Bush Street, 13th Floor, San Francisco, CA 94104 • 415-776-2211



Capturing HEAT

Written by Dean Still and Jim Kness

Reviewed by Richard Perez

Capturing HEAT is a hands-on, do-it-yourself, guide to five different and efficient cookers. Two of the cooker designs use direct solar energy, two efficiently burn wood, and one is an insulated box which reuses existing heat in the pot and food. All are simple to build. The plans are detailed and complete.

This book is about cooker construction with common hand tools and non-esoteric materials. For example, the wood burning “Winiarski Rocket Stove” uses a five gallon, square, cooking oil tin, some stovepipe, wire, and a common tin can. No high tech materials here, the Rocket even uses wood ashes as insulation. While the raw materials are dumpster divings, the design is sophisticated and well thought out. The stove features input air control and input air preheating. The Rocket reaches firebox temperatures above 1,100°F—this makes for efficient combustion with a minimum of wood consumption and pollution.

A larger variation of the Rocket stove is made from two 55 gallon drums. This bread oven will bake 20 loaves of bread (about 66 pounds) while consuming only 11 pounds of firewood.

What really impressed me about all the designs in *Capturing HEAT* was the no nonsense technical explanations of how that specific cooker and heat in general work. This depth of information allows the cooker builder to easily adapt the design to specific needs and materials. Although this book is slim, only 35 pages, it contains more hard information than most books ten times its size.

Access
Capturing HEAT is available from Aprovecho Research Center, 80574 Hazelton Road, Cottage Grove, OR 97424 • 541-942-8198 • FAX 541-942-0302 • Internet email: apro@efn.org • Web site: http://www.efn.org/~apro

The cost of *Capturing HEAT* is $7 shipped prepaid inside USA. Copies available to people working overseas for the cost of postage.

the Wizard speaks…

Tools

Last time I discussed the forces which drive technology. This time I will look at the tools that these forces use. There are essentially two types. These are the rational or scientific, and the intuitive or magical.

Science uses abstract symbology such as logic and mathematics to attain its objectives. Science is a linear process in which the mind is the main interpreter. Science confronts reality indirectly.

Magic is different. It is a non-symbolic, direct confrontation with reality. Magic does not depend on the mind. The vehicle of magic in this world is the tripartate system of body, brain, and senses. Magic is a parallel process with immediate feedback.

Since science is rational and magic intuitive, the levels of pattern recognition are necessarily different. Scientific patterns are usually quantitative while magical ones are qualitative. There is, of course, some overlap. The scientific path is like a straight line, while that of magic is like an expanding sphere.

Physical forces use science and instinctive magic to produce their technology. Social forces use advanced scientific techniques as well as rudimentary magical ones. Spiritual forces, however, use highly developed magic along with the scientific method to attain their goals.

As science has progressed to bring us the technology of today, magic must progress to bring us the technology of tomorrow.

Marital Issues

Like many of your readers, my husband and I are Home Power junkies! Yes, we fight over each new issue when it arrives, excitingly flipping through it together to find out what the topics are and then the winner slinks away to some corner of the house to consume it.

We learned of Home Power through Real Goods. We learned of Real Goods from a friend when we mentioned that we wanted to eventually live in an energy independent home. It's been two years but we're getting closer.

Since that time we've sold our rental house in Florida, got jobs working from home (so it does not matter where we live), found our scarcely populated county in Northeastern Pennsylvania and scoped out a plan. We've read everything we could find on alternative energy as it pertains to homes and set some goals.

We're still four or five years away. Next month we move to Lanesboro, PA (population maybe 100). We purchased a handyman special for $22,500 and will renovate it to use as little energy as possible and propane, wood or solar where possible. This gives us a basis of operations and let's us really get to know the area. Then we're going to start a search for up to 100 acres of mountain land. There's not a whole lot of sun up there during the winter, so we want to make it a solar-hydro system. The land has to have a water source for decent hydro. Enough to deal with a computer or two in addition to the normal household use.

Once we have the land, we plan to slowly build an underground home which uses as little power as possible. When it does use power, it will be provided by the sun or nearby stream.

I wanted to let you know that through all of this Home Power inspires us, teaches us and prepares us for the future. At first it was only a dream. Now it's a plan.

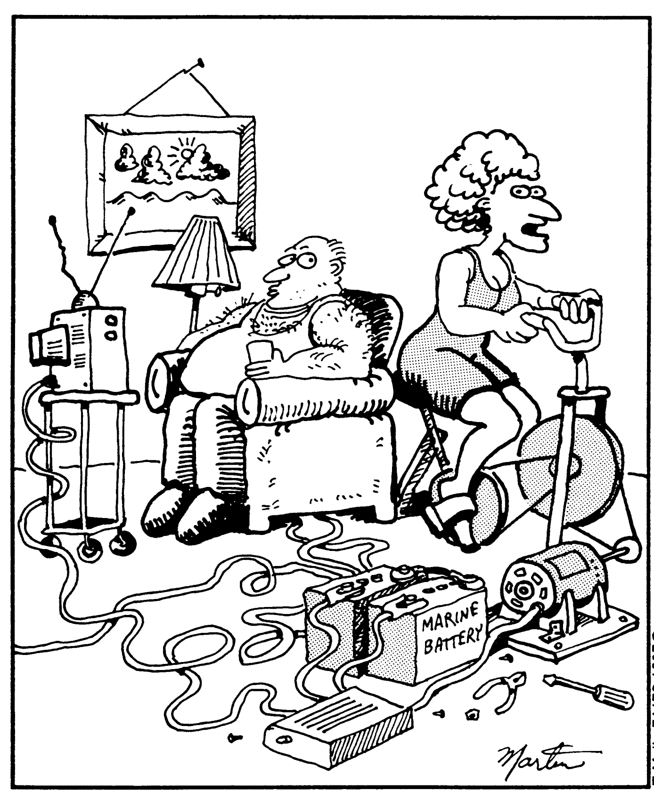
Thanks for putting out such a wonderful magazine!. Please keep it technical. Lori Martin, Lanesboro, Pennsylvania

Thanks for the flowers, Lori, and I hope that we can continue to supply you with the technical RE information you need. My personal experience is that dual RE input systems are synergistic—the whole is greater than the sum of its parts. We use both PV and wind systems here at Funky Mountain Institute on Agate Flat. The second RE source (wind) has reduced our generator operating time from about 200 hours per winter to less than 50 hours per winter. There are also periods here when both PV and wind sources are active. We make use of surplus energy by pumping water into our holding tanks, heating water, and sometimes even cooking in a microwave oven. Your idea of hydro as a second source is sound. Of all the RE inputs, only hydro offers power input 24 hours a day. Don't be too concerned about computer power consumption unless you are running big systems many hours per week. My Big Mac system has all the bells and whistles, including a 21 inch color monitor, and the system consumes less than 300 watts. The big question is not the computer, but how much the computer is used. Richard

Cheap & Simple

I have been a reader of HP since #2. Nearly all of what I have learned about RE has come from you guys. One of these days I will write up my system for your mag, haven't seen one like it yet—just a simple, medium-power, 95% ac system to power my old single wide trailer. I invested less than $3,000 and have all the power, battery capacity, and charging I need—and in four years operating I have had no maintenance costs. Ken Lefsaker, Grangeville, Idaho

Hello Ken. I encourage you to write-up your system for publication in Home Power. Almost all of our system articles come from our readers. This allows us to share what works and what doesn't. Home Power is all about hands-on information. The only way to get this information is for the folks who have actually done it to share their experiences. I'm looking forward to your article. Richard



"Where's them PV panels you been promising me?"

Common Sense
Speaking for Jim Agee, who is my uncle and currently in Italy: Renewable energy is the only common sense solution for now and all future generations. If we can put a man on the moon certainly we can generate cost effective power from RE. To continue to degrade our environment with current energy practices when viable green alternatives are available is, in my opinion, a moral wrong doing. Tim Humecky/Jim Agee, Nevada City, California

Well, Tim, I think you've got it right—there is really no excuse for ignoring Nature's freely delivered energy while polluting our planet by burning fossil fuels and creating more nuclear waste. The technology is here right now. The environmental dangers of continuing combustion and nuclear energy are clear. The issue of cost would be clear if all energy sources were competing on a common basis. RE is a new technology and it will take some time before it can compete with heavily subsidized and well established energy sources like coal, gas, and nuclear. Part of the financial problem is that RE makes us energy independent. If enough of us use RE sources, then who will buy commercial power? From a business standpoint, it is much more profitable to rent out power rather than to sell the user the ability to make his own power. Coal, gas, and nuclear are based on ownership of the energy source. Who owns sunshine? Richard

Pulse Charging
You indicated an article on your testing of the Mini-Pulse and Dura-Pulse device for rejuvenating lead-acid batteries would be forthcoming. I have been using a unit but am anxious to see your article & test results.

I have used an older, small, electric vehicle (1976 Citicar) since 1981. I have used it throughout some winter seasons in central Wisconsin (even at 29°F). There is absolutely no reason why most people could not do most, if not all, their local and short regional driving NOW in electric cars. Many designs are available from small companies, conversions etc. are more comfortable and traditional than mine. Modification would make longer, interstate driving possible. Dr Henry Shaw, Stevens Point, Wisconsin

Hello, Henry. The reason that we have not published test reports on the Mini-Pulse and Dura-Pulse devices is that the company making them went out of business. This is really a shame because our testing here indicated that older lead-acid batteries could be rejuvenated, and new batteries have their life extended, by feeding them these electrical pulses. I am now testing some pulse devices made by another company (PulseTech Products Corporation, 3131 Premier Drive, Irving, TX 75063 • 800-580-7554 • FAX 214-550-8286). I figure that it will take several more months before we have enough data to properly report on these new pulse devices, but initial indications are favorable. Richard

Enthusiastic
I read the June/July issue cover to cover and word for word. Sorry I missed the other articles in the series on converting the Volkswagen to electric. This magazine gave me lots of ideas for projects to last me a lifetime. And the enthusiasm to get started. Please get my subscription started ASAP. J P Shull III, Dallas Texas

T*hanks for the subscription, J.P. You can order the back issues with the rest of Chuck Hursch's VW conversion by giving Kathleen a call at 800-707-6585. Richard*

A Thank You
Solutions Group wishes to express thanks to all those businesses and individuals who contributed to the public liability insurance and other costs for the July 4th Weekend Renewable Technology Fair and Electric Vehicle Constructors Invitation and Distance Event.

Congratulations to all those who exhibited progressive and solutions-oriented technologies and pollution prevention information and displays. Thanks to all those who volunteered their time to ensure that the events and organization ran smoothly.

We had visitors form California, Oregon, Washington, Canada, Montana and southern Idaho. Technologies included solar electric, solar thermal, solar lawnmowers, solar pumps and small hydro, straw bale construction, affordable housing, and a high tech teepee from Missoula. Pollution prevention, recycling in business and information on Rock Creek and ASARCO, eco tourism, biofuels, fuel savers and supper efficient wood burning systems. Public transit, electric vehicles and sustainable building materials. Cool drink was provided by the Evergreen Coop. Students took video at the Fair, another crew filmed the EV event on Sunday. There was online bulletin board access, and press coverage reached thousands by print, video and radio.

Excluding time, the weekend cost under $700 and attracted around six hundred visitors. NICE provided downtown and City Beach shuttle, and the Street Fair organizers plugged the Renewables Fair repeatedly. Only four of the Renewable Technology Fair exhibitors didn't make it, and only two of the electric vehicles teams invited were absent.

The weather was outstanding all weekend. The electric vehicle event was an experience! Many thanks to all. Where shall we take it from here? Tim Smith, The Solutions Group, 206 N 4th Ave Ste 101, Sandpoint, Idaho 83864

Well, Tim, keep the momentum up. We are publishing your address so that folks who are interested can get in touch with you. Think about setting up a permanent infrastructure for the event. If you need help organizing the details, give the wonderful folks at the Midwest Renewable Energy Association (MREA) a call at 715-824-5166. Richard

Zapi
I was lucky enough to start getting your magazine when it first came out and still look forward to each issue. It was your articles on electric cars that inspired me to make my own back in 1993. When I started my project I wasn't thinking of using the car for work as I have a lawn business and pull a trailer about 30 miles a day and sometime further. After talking to Shari Prange from Electro Automotive I decided to build it with that in mind and have used it for the last three years towing a 1500 lb. trailer with all my lawn equipment. One thing that I soon found out but have never seen any one comment on is that the range goes up as the speed goes down. In the old days when I would have to drive far I would just slow down a little and the range would increase. Over time I have installed

outlets at some of my customers homes and when it's time to head home I'm all charged up. I didn't have the best of luck with the Curtis Controllers and when Solar Car offered me a Zapi I bought one. It has regen brakes, which with my load is really nice, and seemed to work a lot better than the Curtis. The other side of the coin is it cost twice as much, was twice as complicated to wire and now, because of my own sloppy wiring, needs repair. One of the wires going to the motor was rubbing on a part of the frame and had rubbed through the insulation. Then I had a wire come off the pot box (gas peddle) and when that touched the frame the Zapi was zapped. Now Solar Car, the people I got it from, are out of business. I have written to Italy but I would like to find some one here in the states that could repair it, as I would rather have it fixed here than send it to Italy.

Keep up the good work. Steve Chunn, 1918 S 34th St, Fort Pierce, Florida 34947

How about it EV folks, can anyone out there repair Steve's controller? Richard

EV Recharge

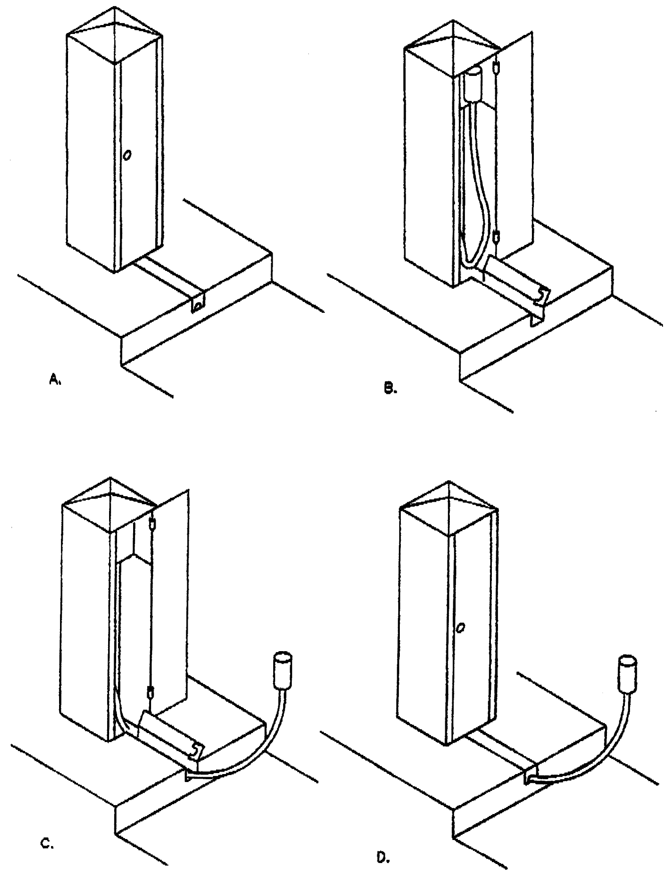
Dear Crew of Home Power, Shari Prange's article on Chuck Hursch's EV conversion in HP#52 highlighted one of the difficulties facing EV'ers. "The last part of the conversion was almost the showstopper: installing the charging station at home" (HP#52). The problem for a private individual is how to provide charging at the home base if you don't have off-street parking.

The UK is way behind many countries in promoting EVs. There is no support from the government, industry or the media. Progress is only being made by a few small companies, a few local authorities and a few dedicated individuals, such as those in the Battery Vehicle Society.

In common with many of your contributors to GoPower, I am very keen to go electric. However I do not have any off-street facilities for charging. For the last 12 months, I have been working with the local utility, London Electricity, to have my own personal charging point built in the public footpath (sidewalk) right outside my house. London Electricity have been surprisingly supportive. They have gone to a lot of trouble devising a system which complies with the regulations in this country. The most taxing are that the charging point must be set back 0.45 m (18 inches) from the kerb edge AND must not cause an obstruction of this gap when the cable is connected to the vehicle.

Incidently my local authority, the London Borough of Lambeth, are also supportive of this unique project for the UK. Once the charging point is in place, they have offered to mark out a reserved parking space and erect a special sign.

However having done all this work, London Electricity are dithering on the brink of installing the first charging point. The charging post is proving rather expensive. They fear that if this first post is a success, they will be asked to replicate it for others and be asked to subsidise the others. In view of the unit cost, London Electricity are now wondering what happens elsewhere. Haven't other countries had to confront the situation of providing charging for EV'ers on-street?



Through your letters column, I am appealing for any information on charging systems in public places. In particular those for an individual's use which are also a low cost design, not needing a billing system for multiple users.

This information could provide London Electricity with sufficient confidence to build the first one in the UK, an important milestone. Sincerely, Simon Roberts, simonr@zed-inst.co.uk or fax +44-1932-243603 or post to 4 Lansdowne Gardens, London SW8 2EG. — Simon Roberts, ZED Instruments Ltd

Well here we go, Simon. I trust our readers will send you info on how they charge their EVs in public places. I especially liked the part of your letter where the local authorities "offered to mark out a reserved parking place and erect a special sign." If I correctly remember the shortage of parking places in London, this feature alone could bring many EVs to England. Richard

Hello, Old Friends

I don't mean old, like ancient, I mean long term.

I have an address change. I am still living at the house address that you've had these many years (see HP#12, page 5), but am preparing to be more "portable".

After returning from my 7 1/2 months in Africa, backpacking, I found a need to divest myself of things, things that I have been attached to, but no longer serve me, like tons of stuff I haul around. Also, I am selling my house (in Sandpoint, Idaho), or if doesn't sell by late fall, I will lease it.

I have had a 15 foot travel trailer that I have used for a couple of years, but now have traded it in on an 18 foot, self-contained. I may live in it.

As with the 15 foot, it is now completely "solarized", using a pair of Interstate 220 Amp golf cart batteries and two pair (4)–35 W panels that are hinged so that they can be stored in a neat pocket I built between the propane tanks and the front of the trailer. I had these in the 15 foot trailer also, but without the neat pocket.

The panels that I have had on my house for nine years are Sovonics, and since they no longer do any manufacturing, I bought all the laminates they had left—29 of them. Twenty-five were used to charge my electric car, and four for the trailer. Since they are amorphous, they are lightweight, allowing for the fold-up, hinged concept.

So, with my power consumption mostly 12 VDC (laptop computer, lights, stereo, TV, and maybe a camcorder), I have a small 300/500 W inverter that will run my printer, hand mixer, electric drill (not too strong), I'm all set. Orin Bridges, PO Box 11, Dover, Idaho 83825

It's great to hear from you again, Orin. I've always talked about how RE system can grow, but now you shown how they also can shrink! Good work on simplifying your life, sometimes I think I should join you. Richard

RE Formula?

Is there a formula to go by when it comes to the number and size of batteries in a bank and the.number of watts of PV power to keep batteries up? Art Haggerty, Lindenhurst, New York

In a word, no. Sorry, Art, such a formula doesn't exist. There are rough guidelines, but each system is different. For example, each system is in a different place and this alone means differing amounts of solar exposure. Each system has different users with differing electrical demands. You can do a fair job of sizing your system by surveying your electric energy requirements. How much electricity do you need? Figure it out in kiloWatt-hours per average day. Your PV system must, at a minimum, produce this amount of energy daily. In order to recover from cloudy periods, the PV array size must be further increased to recharge the batteries. How much of an increase? Well that depends on your climate—what are the durations of alternating sunny/cloudy weather? In terms of battery storage, how many cloudy days do you have in a row? The battery should hold enough energy to get you through at least your average cloudy periods. And then there a other factors which influence battery size—temperature (average and extreme), and type of battery technology (deep cycle, shallow cycle, sealed, vented, acid or alkaline). Add to all these vagaries the fact that PV modules and batteries come in different sized packages and you have a confusing situation.

If you want a cost effective system, then all these variables must be accounted for. The only option is buy much more than you need and this can be very expensive. Check out the system articles in Home Power. Each system is properly proportioned to match the user and the environment in which it operates. Check out the index in HP53 under Site Survey and System Design. Unless you want to throw money at the problem, the alternatives are either doing the homework, or hiring a designer/installer who has already done the homework. Richard

Electronic Ballasts

When I requested from IOTA Engineering, a manufacturer of electronic ballasts, to clarify to me the life expectancy of low voltage fluorescent lights being frequently switched On and Off, I received a letter from Stephen W. Shell that I consider to be very professional, and down to the point. Enclosed, I'm sending you a copy of that letter for publication. I sincerely think that it can be edited to retain the technical core, which I think will help some of the readers to better understand the details concerning this subject. Hector L Gasquet, El Paso, Texas

IOTA's Letter to Hector Gasquet (edited)

Rated lamp life is typically based on three hours of operation per start; therefore, in applications where the lamp is started more often than three hours of operation, lamp life will certainly suffer.

However, poor ballast design is inherently more detrimental to lamp life than the on/off switching. Most ballast used in the PV market are what we label "consumer products."

These ballast are typically inexpensive and use a single transistor switching design. Fluorescent lamps are designed to operate on a sinewave with a lamp crest factor of 1.6 or better (1.4 being a pure sinewave). Crest factor is the ratio of peak current to RMS current. The single transistor ballast generates an asymmetrical waveform which has a a crest factor far higher than the recommended 1.6. These ballast are designed for applications where lights are used infrequently and for low cost markets. As a side note, many of these ballast do not have open circuit protection. Once the lamp fails, the ballast will fail also.

IOTA's ballast are manufactured for the "commercial market" where continuous, reliable, efficient operation is required. Our ballast use a two transistor design, operating in a push-pull configuration. The output is a sinewave with a crest factor t or better than 1.6. Our ballast have reverse polarity protection and are also designed for open circuit operation as well as short circuit protection.

In summary, although there are numerous variables which affect lamp life poor ballast design is the primary failure mechanism. Hopefully, this "sheds a little light" on the subject. Stephen W Shell, IOTA Engineering Co., PO Box 11846, Tucson, Arizona 75734

No Power Lines

A year ago our neighborhood organized to keep a small minority from bring power across the highway and down our road. Home Power was popular at the meetings and I hope influenced some borderline people towards the future. The intense drought and excessive wind have kept us all in plenty of power. Mark Kaltenbach, Cerrillos, New Mexico

All right, Mark! When I hear that small scale RE has stopped another new power line, I just start grinning. Keep up the good work! Richard

Winter Wind
We felt connected to others in this field right away upon reading Daniel Whitehead's article. We know about the wind generator he put up in Clinton and always have driven by it in awe. It's too bad about his crabby neighbors. If we were his neighbors, we'd be knocking on his door to find out how he did it. In fact, now that we know where he moved to, we'll be contacting him one of these days to see if he can help us.

We're at the growing-pain stage. We started with a weekender kit from Real Goods, which only had one 48 watt panel. Luckily we started with four 305 amp-hour batteries for a good price. We added a set of Quad-Lams and an Air 303 wind generator. With another set of three recycled PVs, we've outgrown our SCI 15 amp charge controller and have realized that we need to upgrade our battery bank. We really enjoy the extra power from the wind generator to keep the batteries topped off in the winter. Our solar panels just weren't enough the winter before last to keep the batteries charged. We're very interested in your homebrew articles. We are not electrical engineers and probably are a good example of complete novices. We've scratched our heads many times, especially when we added the wind generator. Keep up the good work. Pat Walke, Preston, Iowa

Thanks for the flowers, Pat. We'll do our best to keep the homebrew articles coming (check out the neat and simple Phantom Load Detector on page 36 of this issue). And, Readers, keep on sending in your homebrew articles. Since I've been working on the magazine so much, I've less time to spend at the electronics work bench. Richard

Intertie Inquiry
I live in Elkhart, Indiana, hardly a hotbed of renewable energy activism. Although I dream of one day going completely off the greed, er, gridx, I think at this point a utility intertie system may be my best alternative.

Do you know of anyone in my area who has one? Do you know what laws Indiana has regarding net metering? And perhaps most importantly, do you know if my electric company, American Electric Power (formerly Indiana Michigan Power), has any past behavior which would give a clue as to how receptive they would be if I approached them? Any answers you (or HP readers) could offer would be most helpful. Thanks. Robert M. Kurtz, Elkhart, Indiana. Internet email: HKandRK@aol.com

I do not know of any RE Intertie systems in Indiana, nor anything about the laws there. I do know that there is a federal law (PURPA 1979) which requires the utility to purchase your RE surplus. Perhaps a reader in your area will contact you with the local data. Readers without Internet connections can send their info to Home Power and I will forward it to Robert via the net.

I am entirely in favor of utility intertied systems. It makes the system more efficient, lessens the demands on batteries, and gives the utilities a reason to survive in the next century. Richard

It Works!
I want to say thanks! We now have our first PV system. It is small, only powering two lights and a small tape deck, but it's functional and safe. We plan to expand and have a complete house system one day. So again, Thanks!

P.S. Do you folks know of any additional hydrogen systems and gray water systems? Carl and Danielle Hosler, Firestone, Colorado

Congratulations on your new system! And it's larger than you may think. Karen and I started with a small system that powered two lights and the tape deck. From little energy seeds, big systems will grow!

Check out the index in HP53 under Hydrogen and you'll find several systems listed. Contact the American Hydrogen Association, 216 South Clark Drive, Ste. 103, Tempe, AZ 85281 • 602-921-0433 • FAX 602-967-6601
• e-mail: aha@getnet.com
• web site: http://www.getnet.com/charity/aha

In terms of gray water system the folks to talk to are: Oasis Design, 5 San Marcos Trout Club, Santa Barbara, CA 93105 • 805-967-3222 • FAX 805-967-3229. Let me know how the gray water system goes—Karen and I are planning to install one here at Funky Mountain Institute on Agate Flat. Richard

Tree Planting Organizations
I'm looking for tree planting programs in tropical countries. I bet that some of your readers know about planting organizations in Burundi, Malawi, Vietnam, Bolivia, etc. We hear a lot about American Forests and the Global ReLeaf campaign, but I sometimes wonder how much of a donation to a U.S. non-profit really gets to the tree planting in Africa and Asia. Please ask readers to contact me at: Steve McCrea, South Florida Electric Auto Association, 1402 E Las Olas Blvd #904, Fort Lauderdale, Florida 33301,
or by Internet Eail: 71524.2372@compuserve.com

Handy Stuff
Got a lot of handy stuff out of issue #54: Now I know that my 80 ah gelcell has type "L" terminals, maybe I can find better connectors. Stainless steel bolts and flatwashers seem to be doing OK, but after reading your "Confessions of a Battery Abuser", I'm felling a little guilty around the solar ham shack.

Re: Your reply to John Morris' letter (Urban Solar PR), I recall the Ben & Jerry's solar powered bus, loaded w/panels. Sure got my attention! I imagine a solar-powered float in any old parade might show the public that it's feasible. All those generators laboring away to run sound systems, which have to compete with the generator to be heard by the admiring throngs. I know the Shriners in our 4th of July parade loved my solar/fan hat!

One cautionary note on your reply to Mr. Mossberg about sealing connections with RTV: most of that stuff will corrode electrical connections fairly quickly, just as if you'd used acid core solder. There's a version which won't (I forget its name), but it isn't easy to find. So the odds are stacked against you when using RTV. Jim Tolson, KF9CI, Skokie, Illinois

You're right about the RTV, it does out gas acetic acid (vinegar) as it cures. I usually give the connection a very thin coat and wait for it to cure before applying a heavier coat. It sure seals connections that are exposed to the weather. Richard

A Word in Edgewise

After hungrily loitering around the coffee shop every couple of months for a year now to get my HP fix, I've decided to admit my complete dependency and get a two year subscription. Love the great job you all do, the healthy and (mostly) intelligent debate that conducts itself in the letters area, and hey, don't skimp on the politics. The motive force that has gotten the world into the hyper-consumptive mess it's in, and the inertia that's keeping it there, is firstly politico-economic, and since money talks so much you can't get a word in edgewise, you might as well talk about politics, even if you may be preaching to the converted. The principles discussed do eventually corrupt some minds outside our little arena, although maybe a few less now that I won't be hanging around the coffee shop so much.

That means I'll be spending more time in my little timber framed passive solar mini-barn, two miles from the power lines. My 150 watt rooftop array supplies all the electricity I seem to need. Even running power tools pretty frequently I have yet to take more than a 20% bite out of my two L-16s.

An interesting thing I found when shopping for an inverter, with the help of Daniel at Direct Power and Water in Albuquerque, is that the Power-To-Go PC-1500 model at about $400, is identical to the Statpower 1500 watt model, usually selling for nearly $800. Odd. The inverter works beautifully and has no trouble running a 10 amp Skilsaw, even on long rip cuts.

I was fascinated by the article in HP#53 on the solar ice maker. It had the first decent explanation I've seen of absorption cooling, a topic I was very curious about since I recently installed an old (1939) Servel fridge. It works great, but of course it uses twice as much gas in a month as my stove and on-demand water heater combined, which makes me wonder if anyone out there has ever solar -assisted one of these things, say with a glycol loop to apply heat to the generator section in the daytime?

And how about an article on the off-grid communications scene? Andrew Perchilk from Vermont raised the question in his letter in #54. I'll bet lots of folks are wondering the same thing as he, and your own system sounds like a sizeable investment. I was able to get a 12 watt radiophone for about $700 with service at $50/month. There must be a lot of different options in different parts of the country.

Anyway, can't wait for the next issue. You guys just get better and better. Chris Corkins, Albuquerque, New Mexico

Applying solar heat to the propane fridge is difficult. The fridge wants to see high (greater than 500,F) temperatures and that's hard to move from a solar collector to the fridge. I'll work up an article about back country communications (we've run several in the past, see the index in HP53 under "Communications." The bottom line depends on how much you use the phone. Considering that we use it a lot (as in all the time during business hours), it is cheaper for us to own the system rather than pay airtime at between 35¢ and 75¢ per minute. We have about $4,000 in the phone system and are billed just like any hardline business phone. Richard

Writing for *Home Power* Magazine

Home Power is a user's technical journal. We specialize in hands-on, practical information about small scale, renewable energy systems. We try to present technical material in an easy to understand and easy to use format. Here are some guidelines for getting your RE experiences printed in *Home Power*.

Informational Content

Please include all the details! Be specific! We are less interested in general information, than in specific information. Write from your direct experience—*Home Power* is hands-on! We like our articles to be detailed enough so that our readers can actually apply the information.

Article Style and Length

Home Power articles can be between 350 and 5,000 words. Length depends what you have to say. Say it in as few words as possible. We prefer simple declarative sentences that are short (less than fifteen words) and to the point. We like the generous use of Sub-Headings to organize the information. We highly recommend writing from within an outline. Check out articles printed in Home Power. After you've studied a few, you will get the feeling of our style. Please send a double spaced, typewritten copy if possible. If not, please print.

Editing

We reserve the right to edit all articles for accuracy, length, and basic English. We will try to do the minimum editing possible. You can help by keeping your sentences short and simple. We get over three times more articles submitted than we can print. The most useful, specific, and organized get printed first.

Photographs

We can work from any photographic print, slide, or negative.

Line Art

We can work from your camera-ready art. We can scan your art into our computers, or redraw it via computer. We usually redraw art from the author's rough sketches.

Got a Computer?

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Q&A

Choosing and Housing a Battery
I started with issue 36 and I have the CD ROM Solar I, Great magazine. I can't wait for it to come each time. We are breaking ground this month on our new all solar home in Idaho Springs, Colorado. I hope to add a small wind generator next year, we will use about 7,000 watt-hours per day.

Choosing a battery will drive me crazy. Spend big bucks now, $8,000+ for an alkaline or $2,500 for T105s, what to do. You told Jerome Morrow of Montrose, Colorado to keep his battery warm in #52. What is warm? How do you keep a power shed in Colorado warm? I could have 24 Trojan T105s in a separate power shed. What about heat (?)vs gases? Explosion? Details, details, please?

I will build my house or at least the contractor will build it with my 10,500 watt generator (propane), which will become my backup power/charger. Ron Cadenhead, Evergreen, Colorado

A super-insulated (R60 everywhere), power shed with a glass south face to capture solar heat works well in cold climates. Have the generator dump its waste heat into the power shed during the coldest parts of the winter. Add an air-to-air heat exchanger on the genny's exhaust pipe, and pipe the liquid cooling the engine into a radiator in the battery compartment.

Consider locating the batteries below ground. See the power sheds constructed by Chris LaForge (HP#40, pgs 6-12) in Maine. Chris used a defective (and therefore cheap) unused septic tank as an underground battery enclosure. The batteries themselves can act as part of the thermal mass in the building. I recommend starting out with a deep cycle, lead acid battery. There are currently no domestic-made alkaline cells which are cost effective when compared to lead-acid. I'd prefer Trojan's larger L-16 to their smaller T-105s. The temperature in the power shed should be kept above 40°F during the winter. Ideally the lead acid cell wants to work at 78°F. If the cells are fully charged, then freezing isn't a problem until the temperature falls well below 0°F. If the system is left unattended during the winter, then automatic controls can easily start the genny, recharge the battery, and heat up the shed all at the same time.

Battery gassing is not a problem—use Hydrocaps on the cells and provide ventilation for the battery compartment in (or under) the shed. We use a simple circuit (see Homebrew HP33, pg 81) to turn on two 6 watt sparkless exhaust blowers (muffin fans) in our battery compartment.

Consider putting up the power shed before beginning construction of the main house. This will save you from having the generator yammering all the time during construction. We've had many letters for our readers saying that they were glad they did the power shed first. With your projected energy consumption of about 7 kWh per day, you will have a large inverter. This inverter will be more than able to power the construction tools. Construction places very intermittent demands on the system. This type of service is much more efficient when sourced by the inverter/battery rather than the generator which must continually operate. Richard

Current in Europe
Your magazine is a true blessing and has empowered myself and many others with the knowledge, power, and inspiration to be free and independent from the grid power slavemasters. Keep up the good work.

I'm currently contemplating assembling a small PV system (three panels, inverter, and charge controller) with intentions of bring it to northern Spain next summer. My first question is whether or not it is wise to bring an inverter built for 110 usage to a country where most everything runs on 220. It is possible to get adapters, but wouldn't that be overdoing it? Is there a company manufacturing 220 inverters?

Secondly, what is the AE scene like in Europe? Would it be more economical to postpone my purchase of equipment until I get there? What would be a good supplier/contact for AE products in Europe? The regions of Spain I'm going to are rather rainy and not particularly fruitful in regards to daily sunshine. Would PVs be the best route to go or does anyone have any suggestions? Help! Desperately awaiting advice. Choctaw@ROOTLOOPaol.com

Just about every inverter manufacturer makes 220 vac, 50 Hz. models. Use the voltage and frequency that is native to the country. This makes the local electric appliances a happening reality instead of a potential disaster. The voltage converters you mention are just one more thing to break, and using them is less efficient than using the power directly from the inverter. Buy a 220 vac, 50 Hz. inverter.

Europe is in some ways ahead of the USA in implementing renewable energy, particularly PV. Whether it's cheaper to buy the gear here, or wait until you get to Europe depends on factors such as import duties. From the European dealers I've talked to, prices on PV modules, charge controllers, instruments, and inverters are lower in the USA. But, if you are hit with a

heavy import duty on this gear, then the cost advantage evaporates. The last time we took PVs overseas (Colombia in 1993), we just checked eight modules as luggage on our flight from Miami to Cali. When customs asked what the PVs were, we said, "solar panels." The inspector gave us a blank stare and stamped the boxes—no import duties. A good contact in Europe for you is Steve Wade at Wind & Sun, Oxford, England (see ad in this issue). Steve knows his stuff and can probably help out with equipment importation into Spain.

One thing is certain, buy your batteries locally. The cost of international shipment of batteries is high and the route is devious. The design should use locally made batteries so that they can be easily replaced when they wear out. Battery lifetime can be anywhere from four to fifteen years depending on battery type, system design, and how effectively the system is used.

Spain has more than enough sunshine to operate a stand-alone PV system. There are many PV systems operating in marginal solar climates, such as the coast around Western Washington State. Get a battery Ampere-hour meter such as E-Meter or the TriMetric and learn to use it. Size the battery so that it stores at least four days worth of energy. Learn how to back off on energy consumption during extended cloudy periods. Richard

Cell Help

I got my hands on some lead-acid batteries from a UPS system. I am looking for information on EDTA, where can it be purchased? And should the electrolyte be replaced? All the batteries are in poor shape—6.0–4.0 Volts. I have recharged and got a few of them to 12 Volts, but still get a bad reading with the hydrometer. These cells had set for some time, this is my guess, as the building is being remodeled.

I have HP 47–30 (Understanding the Lead-Acid Cell). I am working with the spec's for these cells made by Dual Lite & think they are 12 Volt (6 cell). Would EDTA help these cells? Could you lead me to more information? Ron Royce, Southgate, California

See the MicroAds in this issue. Trailhead Supply sells tetra-sodium EDTA. You do not need to replace the electrolyte in the cells. Your batteries sound as if they are pretty bad shape. EDTA is realtively inexpensive (in comparison with new batteries), and will do no harm, so give it a try.

Dissolve the EDTA in distilled water before adding it to the cell. Use about 1 tablespoon of EDTA powder for every 150 Ampere-hours of cell capacity. Wait until the cells are down on water and add the EDTA dissolved in water. Fully recharge the cells. Use a C/10 charge rate for about 10 hours, then a C/20 rate for another 10 hours. All the cells should gas violently, so keep an eye on the water levels. Radical recharging makes the EDTA more effective and it works more quickly at removing the sulfate crystals coating the surface of the cell's plates. Several radical recharges may be necessary before the cell reaches its full capacity.

Do not try EDTA treatment on sealed cells, or automotive starting batteries. Both these technologies are too delicate for EDTA treatment. Sealed cells can't stand the gassing of radical recharges and auto batteries don't have stout enough plates. Richard

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